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Cottage Farm Combined Sewer Detention and Chlorination Station, Cambridge, Massachusetts

Boston Metropolitan District Commission, Mass

Prepared for

Municipal Environmental Research Lab, Cincinnati, Ohio

Feb 77

TECHNICAL REPORT DATA

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16. ABSTRACT

The Cottage Farm Detention and Chlorination Station was placed in operation by the Metropolitan District Commission on April 29, 1971. The station, located in Cambridge, Massachusetts, diverts and treats combined sewage flows from the Charles River Valley sewer system (15,600 acres) which exceed the capacity of the trunk sewer to the Deer Island Treatment Plant. A maximum of 233.1 million gallons per day of excess combined sewage may be diverted to the station. The Cottage Farm Station, together with the North and South Charles Relief Sewers, collects and treats by screening, skimming, chlorination and settling all flows up to the magnitude of the five-year design storm. Flows up to 1.3 million gallons (MG) are entirely contained in the six detention tanks (1.2 MG) and wet well (0.1 MG) and are fed back to the sewer system as downstream capacity becomes available. In the 38 months covered by this report, the Cottage Farm Station has activated 114 times, 32 of which were entirely contained by the facility and resulted in no discharge to the Charles River. A total of 800 million gallons were diverted to the station, of which 116 million gallons were contained and returned to the collection system. The Cottage Farm Station has achieved significant removals of suspended solids (estimated 45 percent overall removal), coliform bacteria (99.9 percent removal), settleable solids (69 percent) and biochemical oxygen demand (42 percent) at an estimated cost of $293 per million gallons treated.

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February 1977

COTTAGE FARM
COMBINED SEWER DETENTION AND CHLORINATION STATION
CAMBRIDGE, MASSACHUSETTS

by

Commonwealth of Massachusetts
Metropolitan District Commission
Boston, Massachusetts 02203

Grant No. 11020 FAT

Project Officer

Allyn St. C. Richardson
U.S. Environmental Protection Agency
Region I
Boston, Massachusetts 02203

MUNICIPAL ENVIRONMENTAL RESEARCH LABORATORY
OFFICE OF RESEARCH AND DEVELOPMENT
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FOREWORD

The Environmental Protection Agency was created because of increasing public and government concern about the dangers of pollution to the health and welfare of the American people. Noxious air, foul water, and spoiled land are tragic testimony to the deterioration of our natural environment. The complexity of the environment and the interplay between its components require a concentrated and integrated attack on the problem.

Research and development is that necessary first step in problem solution and it involves defining the problem, measuring its impact, and searching for solutions. The Municipal Environmental Research Laboratory develops new and improved technology and systems for the prevention, treatment, and management of wastewater and solid and hazardous waste pollutant discharges from municipal and community sources, for the preservation and treatment of public drinking water supplies, and to minimize the adverse economic, social, health, and aesthetic effects of pollution. This publication is one of the products of that research; a most vital communications link between the researcher and the user community.

This particular effort demonstrated how the pollutional impacts of combined sewer overflows can be mitigated through treatment by screening, skimming, chlorination, and settling such as is provided at the Metropolitan District Commission's Cottage Farm Detention and Chlorination Station in Cambridge, Massachusetts.

Francis T. Mayo, Director
Municipal Environmental Research
Laboratory

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ABSTRACT

The Cottage Farm Detention and Chlorination Station was placed in operation by the Metropolitan District Commission on April 29, 1971. The station, located in Cambridge, Massachusetts, diverts and treats combined sewage flows from the Charles River Valley sewer system (15,600 acres) which exceed the capacity of the trunk sewer to the Deer Island Treatment Plant. A peak flow of 233.1 million gallons per day of excess combined sewage may be diverted to the station. The Cottage Farm Station, together with the North and South Charles Relief Sewers, collects and treats by screening, skimming, chlorination and settling all flows up to the magnitude of the five-year design storm. Overflows of up to 1.3 million gallons (MG) are entirely contained in the six detention tanks (1.2 MG) and wet well (0.1 MG) and are fed back to the sewer system as downstream capacity becomes available. In the 38 months covered by this report, the Cottage Farm Station has activated 114 times, 32 of which were entirely contained by the facility and resulted in no discharge to the Charles River. A total of 880 million gallons were diverted to the station, of which 116 million gallons were contained and returned to the collection system. The Cottage Farm Station has achieved significant removals of suspended solids (estimated 45 percent overall removal), coliform bacteria (99.9 percent removal), settleable solids (69 percent), and biochemical oxygen demand (42 percent) at an estimated cost of $293 per million gallons treated.

This report is submitted in fulfillment of U.S. Environmental Protection Agency Grant Number 11020 FAT (7-Mass-1) by the Metropolitan District Commission under the partial sponsorship of the Office of Research and Development, U.S. Environmental Protection Agency.

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Preliminary drafts of this report were prepared by Mr. William Brutsch and Ms. Elaine Costello of the MDC Engineering Division and Environmental Planning Office respectively. The final report and data analysis were prepared by Richard R. Noss of the MDC Environmental Planning Office.

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This manuscript was prepared by Ms. Sheila Savoie, Inez Gulezian and Joanne Smith. Graphic illustrations were prepared by Margaret S. O'Leary and draftsmen of the MDC Engineering Division.

SECTION I

CONCLUSIONS

The Cottage Farm Detention and Chlorination Station project demonstrates a combination of three techniques comprising a highly effective system for reducing pollution of the lower Charles River by combined sewer overflows. These methods are quite generally applicable, and this report provides data for quantitative estimation of the results achieveable by their combined use.

Much of the value of this project results from enlargement of the interceptors into the North and South Charles Relief Sewers, which are large enough to carry the five-year peak flow from all upstream trunk sewers to the Cottage Farm Detention and Chlorination Station. Thus, upstream overflows occur less than once in five years. No overflow occurs at any point until the total flow exceeds the capacity of the Deer Island Wastewater Treatment Plant or of the sewer from the Cottage Farm Station to the Ward Street Headworks of the Deer Island Tunnel.

The second line of defense is the 1.2 million gallons of storage provided by the detention tanks. This proved sufficient for total retention of the 32 smallest of 114 overflows to the wet well, comprising 29% of the incidents. This retained material is returned to the sewer system as capacity becomes available, with no overflow to the Charles River Basin. The volume of this material returned to the sewer system from totally retained incidents, together with the contents returned from the full detention tanks after each overflow from them subsides, was 116 million gallons, or 14% of the total overflow volume to the station.

Finally, when storage capacity is exceeded and overflow to the Charles River Basin is unavoidable, treatment for the reduction of bacterial contamination and removal of as much other pollution as possible is provided, consistent with cost for a facility used only intermittently. In this case the addition of sodium hypochlorite solution, and detention while it disinfects, reduces the coliform bacterial density by at least 80% and sometimes as much as 99.9%. For moderate rates of overflow the detention tanks provide appreciable sedimentation, and the fine screens at their overflow weirs provide some removal of suspended solids at all flowrates.

The estimated removal efficiencies are given in the following table. The average surface loading rate for the 114 activations was 2011 gallons/square foot/day.

Parameter	Overall removal (including contained flows)	Removal from flow which discharged to the Charles River
BOD	42%	24%
Suspended Solids	45%	22%
Volatile Suspended Solids	58%	37%
Settleable Solids	69%	58%
Total Coliform Organisms	99%	99%

The use of a sluiceway to return the fine screenings to the sewer system eliminated the need for facilities and operators to handle screenings. The coarse screens could be eliminated and replaced with manually cleaned trash racks as the coarse screenings removed were minimal. Fine screenings were estimated to average 17.09 cubic feet (0.48 cubic meters) per activation.

The fine mesh screens (0.2 inch openings) ahead of the detention tank effluent weirs worked effectively and were easily cleaned. Although they were hinged to allow them to swing open to let the flow pass when they became clogged, this rarely occurred.

The diversion of excess combined sewage flows into the Cottage Farm Station occurred more frequently, with a higher average volume, and with longer average duration of activation than had been estimated in the initial design study. This may be accounted for by:

(a) the period of record having above average precipitation

(b) some pumps out of service at the Deer Island Treatment plant causing sewers leading from the Cottage Farm Station to Deer Island to back up, thereby diverting flows to the Cottage Farm Station more frequently and with greater volume than under conditions assumed in the design.

However, the Station has not operated as many hours per year as projected, and more extremely short and extremely long activations have occurred than expected.

Very little odor was ever noticed in the wet well area.

Assuming 33 activations per year and 2 days per activation and subsequent cleanup, there are approximately 300 days per year when the facility is not in operation and could be used for another purpose, such as treating Charles River water. Although initial experiments to reduce the color of the river water by dosing with sodium hypochlorite were not fully satisfactory, other methods are being explored.

Most of the Cottage Farm Station is below ground, and the site is landscaped into a grassy knoll with a bare minimum of access road and entrance building encroaching upon the Metropolitan District Commissions park-like development of the river bank. Where it is possible to locate such a facility entirely outside the green belt along the river, and thus to avoid any impairment of the natural beauty of the shoreline and public access thereto, such an alternative site for the station would be preferable.

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SECTION II

RECOMMENDATIONS

1. The importance to the evaluation of the facility of accurate sampling and complete data collection can not be stated too strongly. Composite samples and average values do not describe such highly variable phenomena as rainfall events or combined sewer overflow quality. Future installations should:

   a) have highly reliable duplicate flow measuring systems such as a calibrated weir and level recorders for influent flows, flow meters and charts on the pumps, and a calibrated weir and level recorders for discharge from the station. The flow measuring systems should be calibrated regularly.

   b) have multiple water quality sampling systems to take samples of influent flows, at multiple depths in the detention tanks, and in the discharge channel.

   c) have an automatically recording precipitation gauge on-site, or even better, located near the center of the area tributary to the station.

2. Given limited laboratory time, more can be learned about the performance of a combined sewer station by conducting intensive chemical and bacteriological sampling for a few events rather than one or two samples from every activation.

3. Future chlorination and detention stations should provide most of the chlorination at the head end of the plant, or as far upstream as feasible, to maximize chlorine contact time. Future stations should be able to bypass the detention tanks, providing only screening and chlorination to the bypass flows. This flexibility, together with the knowledge gained from the intensive sampling program recommended above, should be used to develop alternative operating strategies for different types of overflow events. Operation of the Cottage Farm Detention and Chlorination Station indicates that greater removals could perhaps be achieved by capturing the "first flush" and allowing the remainder to bypass with only screening and chlorination. (See table 8, page 47).

4. Future chlorination and detention facilities should be located away from the shoreline, and in industrial areas if possible, to avoid potential conflicts with future uses of these areas as parkland.

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5. Provisions should be included in future facilities for testing and adjustment of equipment in the absence of overflow events.

6. It appears from experience at the Cottage Farm Station that manually cleaned trash racks rather than mechanically cleaned coarse screens would be adequate for future designs.

7. Because of the problems experienced with roto-dip feeders for sodium hypochlorite dosage at the Cottage Farm Station, metering pumps are recommended for future installations.

8. Sodium hypochlorite storage and dosing equipment should be located in a room separate from all other equipment and separately vented. A floor drain should be provided to direct spilled or leak sodium hypochlorite to the wet well or detention tanks. Both the liquid hypochlorite and the atmosphere in contact with it are corrosive.

9. Heavy-duty spray guns and hoses should be standard equipment for washing down the facility after activations.

10. To achieve the benefits which this type of facility is designed to provide and which must be realized for the substantial public investment which it represents to be cost-effective, the following provisions are absolutely essential:

a. Redesign
When necessary to correct difficulties encountered in operation, management must be prepared to provide the resources and take vigorous action to accomplish redesign and revision. This is particularly true for a demonstration project, for which pioneering design is necessary and therefore some design deficiencies may be unavoidable.

b. Checkout Provisions
Provisions for routine maintenance, calibration and test of all mechanical equipment, instrumentation and automatic control systems, in the absence of an overlfow event, should be incorporated in every facility design.

c. Maintenance in Ready Condition
Management planning should provide sufficient time allotments of skilled and support personnel, equipped with adequate supplies of maintenance materials, spare parts and replacement units to execute routine maintenace, calibration and test, and to keep all equipment including standby units in optimum condtion for immediate and reliable operation.

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d. Integrated System Management
Coordination between the various components of a sewer system is necessary. For example, failure at the Deer Island Wastewater Treatment Plant to pump from the deep tunnels at design capacity leads to surcharge at the headworks, which in turn can lead, and has in fact led, to overflow into the wet well at the Cottage Farm Station at rates exceeding the total pump capacity (one pump more than design capacity) and to flooding of that station. A capability to bypass by gravity directly to the Charles River, while it would avoid such flooding, would in routine use as a substitute for adequate maintenance of pumping and treatment capacity at Deer Island, nullify much of the value of the Cottage Farm facility. Deficiency at Deer Island does in any case lead to increased discharges into the Charles River Basin of both untreated and screened chlorinated combined sewage. Improved communications among these several facilities, and integrated management of the system as a whole would do much to promote awareness of the consequences of operating difficiences, to fix responsibility for them and to instigate corrective action.

11. Future facilities should seriously consider disposing fine screening by returning them to the sewer system by a sluiceway or force main.

12. Fine mesh screens should be used ahead of the detention tank effluent weirs.

13. A medium - sized electrically driven pump should be used to provide dependable, flexible operation at low overflow rates.

14. The threefold design concept embodied in this project has been demonstrated to be effective in reducing pollution by combined sewer overflows. It merits consideration for widespread use.

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SECTION III

INTRODUCTION

GENERAL

The Cottage Farm Combined Sewer Detention and Chlorination Station Figure 1, is located on the north bank of the Charles River in Cambridge, Massachusetts, immediately upstream from the Cottage Farm Bridge. The Cottage Farm Station diverts, stores and treats combined sewage flows from communities in the Charles River Valley sewer system which cannot be carried to the Deer Island Sewage Treatment Plant. This facility constitutes one element of the Metropolitan District Commission's comprehensive program to improve water quality in the Charles River Basin.

The Charles River Basin is one of the major recreational assets of the Boston metropolitan area. Water-based recreation includes motorboating, sailing,sculling, and duck feeding. The Metropolitan District Commission (MDC) hopes to provide swimming as well in the future. The banks of the river are lined with trees and park lands, and are used extensively for walking, jogging, bicycling, reading, sunbathing, and other recreational pursuits.

The Water Quality Standards of the Massachusetts Division of Water Pollution Control require the Metropolitan District Commission to maintain the Charles River Basin in a Class C condition. To fulfill the Class C requirement, the Charles River Basin must be suitable for recreational use such as boating and fishing, have good aesthetic value and be a suitable habitat for wildlife and common food and game fishes indigenous to the region.

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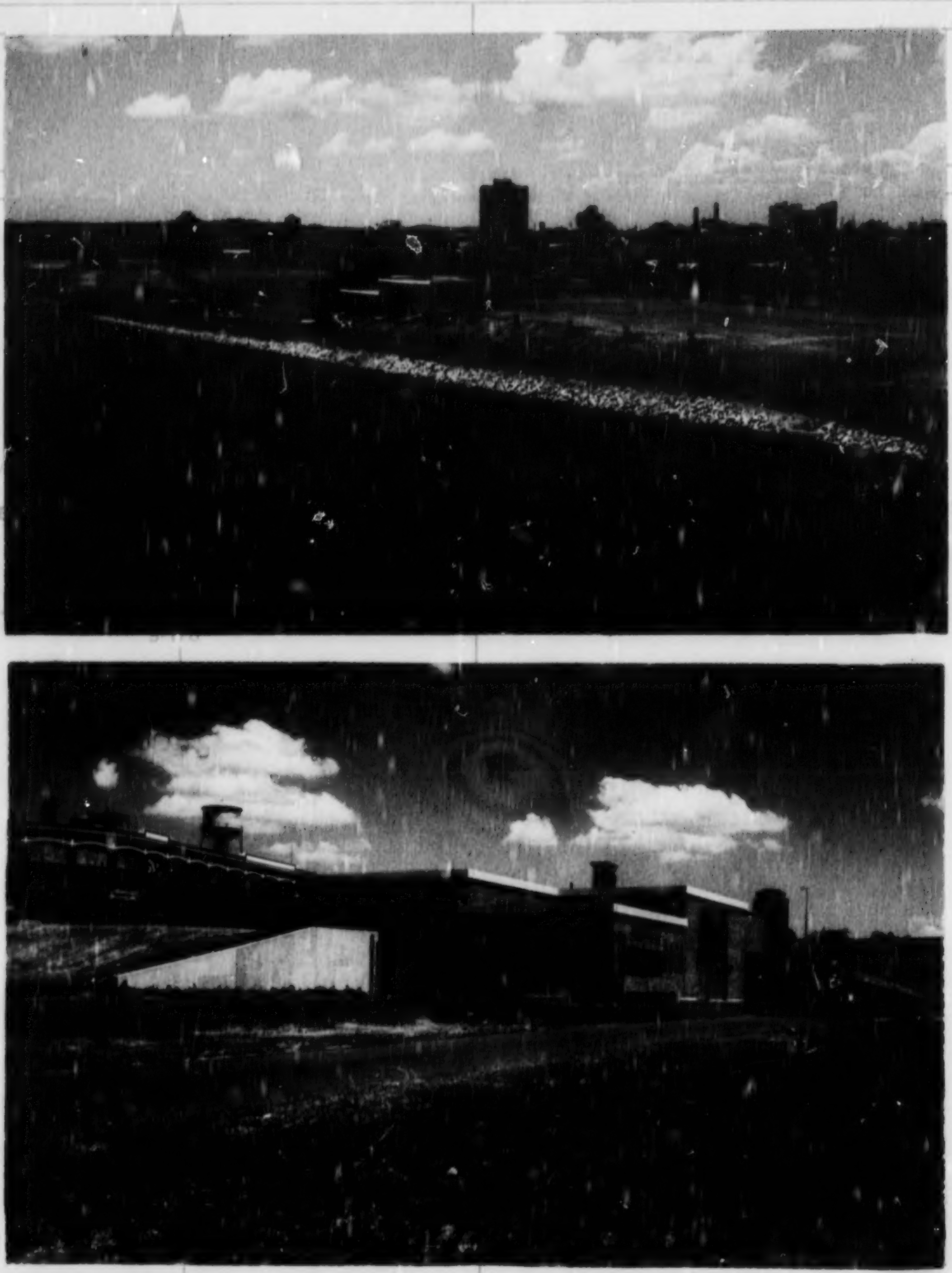

Figure 1. General View of the Cottage Farm Station. View Northwest (top); View Northeast (bottom).

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In the past, the Basin has been severely polluted by the overflow of combined sewage from Boston, Cambridge, Brookline and other communities. Because of the inadequate capacity of the sewerage system and the poor condition of tidegates, regulators, and other overflow structures, local systems surcharged easily and overflows were frequent, occasionally occurring even during periods of dry weather. The Cottage Farm Combined Sewer Detention and Chlorination Station and the North and South Charles Relief Sewers were designed to reduce the frequency, volume and concentration of these overflows. Combined sewage flows which exceed the capacity of the trunk sewer to the headworks facility are diverted to the Cottage Farm Station. The Station treats excess combined sewage flows by screening, skimming, settling and chlorination. Excess combined sewage flows of 1.3 million gallons or less are completely stored within the facility, and are returned to the interceptor sewer after the storm as capacity becomes available for transmission to the Deer Island Treatment Plant. Flows in excess of 1.3 million gallons are treated and discharged to the Charles River Basin.

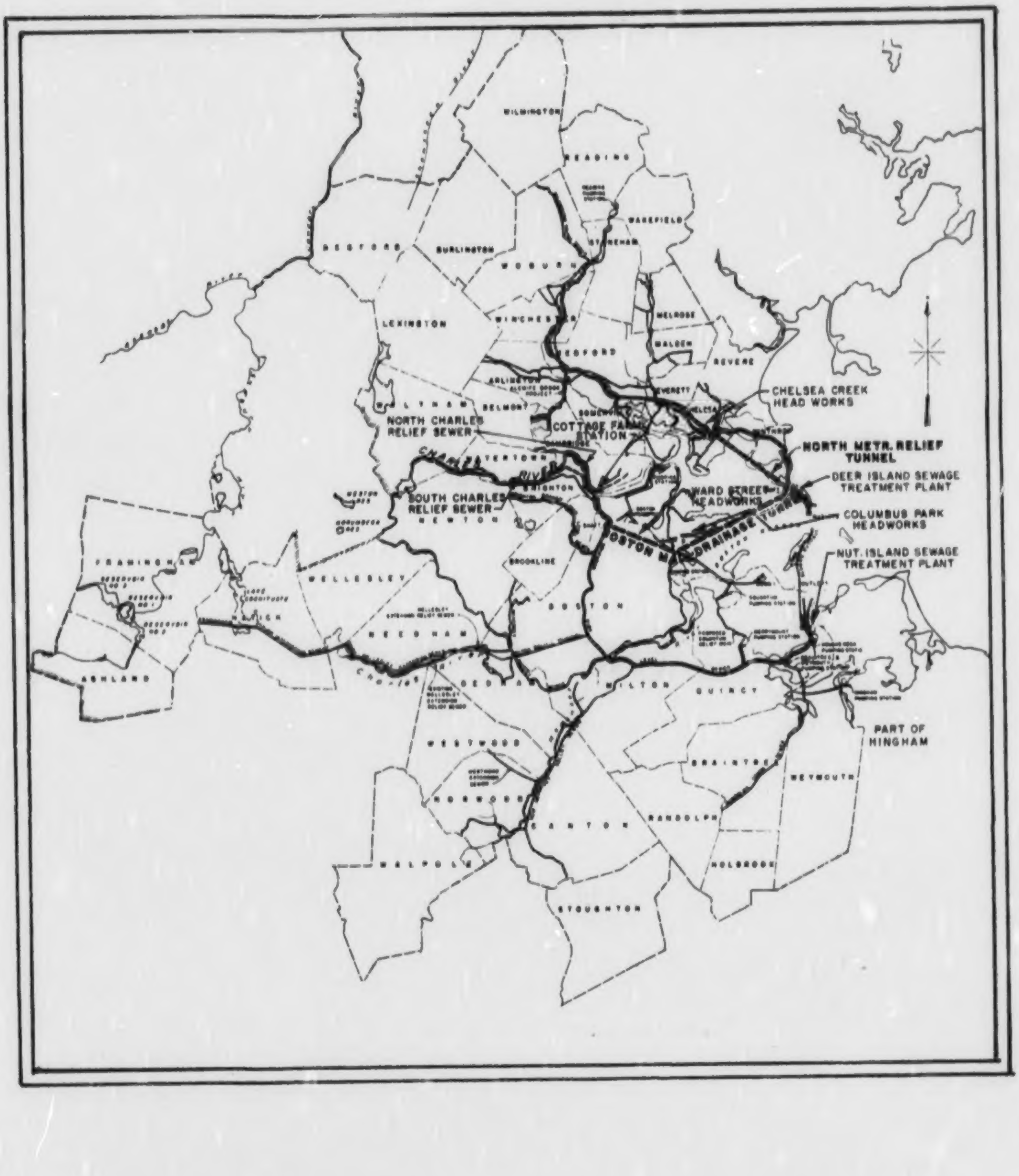
THE METROPOLITAN SEWERAGE DISTRICT

The Metropolitan Boston Sewerage District, the first legally constituted metropolitan district in the United States, was established by an Act of the Massachusetts Legislature in 1889. Today the District includes over two million people in forty-three cities and towns in eastern Massachusetts. Metropolitan Sewerage District facilities include two primary treatment plants with a design capacity of 450 million gallons per day, four headworks, eleven pumping stations, and over 225 miles of trunk sewers.

A comprehensive pollution abatement program was initiated in 1945. This program included the construction of 35 miles of trunk sewers, two deep rock tunnels under Boston Harbor to Deer Island, three headworks facilities, and sewage treatment plants at Deer Island and Nut Island. The plan also recommended a facility to treat combined sewer overflows in the Charles River Basin.

The comprehensive program was designed to improve the water quality of the Charles River and Boston Harbor by reducing the overflow of combined sewage into the Charles River and eliminating the discharge of raw sewage into Boston Harbor.

The major MDC interceptor sewers and treatment facilities are shown in Figure 2. A schematic showing the Deer Island Treatment Plant and the headworks facilities is included as Figure 3.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STONEHAM
BEDFORD
BURLINGTON
WOBURN
LEXINGTON
WINCHESTER
MELROSE
MALDEN
REVERE
MEDFORD
ARLINGTON
EVERETT
CHELSEA CREEK
HEAD WORKS
WALTHAM
BELMONT
SOMERVILLE
NORTH CHARLES
RELIEF SEWER
COTTAGE FARM
STATION
CHELSEA
WATERTOWN
CHARLES RIVER
NORTH METR. RELIEF
TUNNEL
BRIGHTON
DEER ISLAND SEWAGE
TREATMENT PLANT
WARD STREET
HEADWORKS
SOUTH CHARLES
RELIEF SEWER
NEWTON
BOSTON MAIN DRAINAGE TUNNEL
COLUMBUS PARK
HEADWORKS
FRAMINGHAM
WELLESLEY
BROOKLINE
NUT. ISLAND SEWAGE
TREATMENT PLANT
BOSTON
NEEDHAM
ASHLAND
Charles
DEDHAM
MILTON
QUINCY
PART OF
HINGHAM
WESTWOOD
BRAINTREE
WEYMOUTH
NORWOOD
CANTON
RANDOLPH
WALPOLE
HOLBROOK
STOUGHTON

Figure 2. Metropolitan Sewerage District

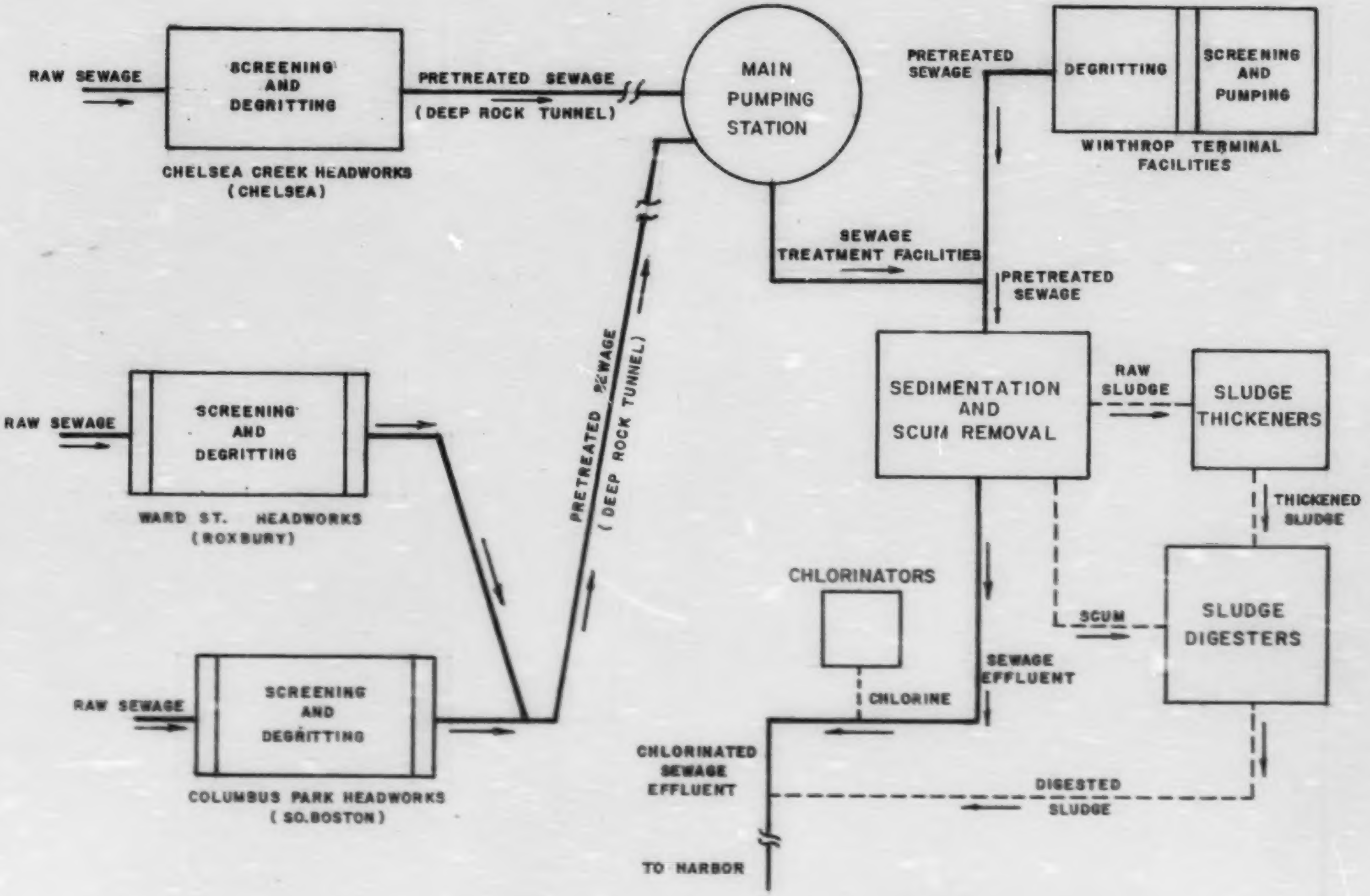

RAW SEWAGE
SCREENING AND DEGRITTING
PRETREATED SEWAGE
(DEEP ROCK TUNNEL)
CHELSEA CREEK HEADWORKS (CHELSEA)
MAIN PUMPING STATION
PRETREATED SEWAGE
DEGRITTING
SCREENING AND PUMPING
WINTHROP TERMINAL FACILITIES
SEWAGE TREATMENT FACILITIES
PRETREATED SEWAGE
RAW SEWAGE
SCREENING AND DEGRITTING
WARD ST. HEADWORKS (ROXBURY)
PRETREATED SEWAGE
(DEEP ROCK TUNNEL)
SEDIMENTATION AND SCUM REMOVAL
RAW SLUDGE
SLUDGE THICKENERS
THICKENED SLUDGE
CHLORINATORS
SCUM
SLUDGE DIGESTERS
SEWAGE EFFLUENT
CHLORINE
RAW SEWAGE
SCREENING AND DEGRITTING
COLUMBUS PARK HEADWORKS (SO.BOSTON)
CHLORINATED SEWAGE EFFLUENT
DIGESTED SLUDGE
TO HARBOR

FIGURE 3. SCHEMATIC OF UNIT PROCESSES DEER ISLAND TREATMENT PLANT.

THE CHARLES RIVER VALLEY SEWERS

Background

Prior to the completion of the North and South Charles Relief Sewers, all sewage flows in the Charles River Valley were carried by the Charles River Valley Sewer and the Cambridge Branch Sewer. Portions of these sewers date to the 1890's. Much of the area tributary to these interceptors is served by combined sewers. The Charles River Valley and Cambridge Branch Sewers and their overflow relief points to the Charles River are shown in Figure 4.

The Cambridge Branch Sewer serves the City of Cambridge and small sections of the Towns of Belmont and Watertown. It originates near the Cambridge-Belmont line and generally follows the north bank of the Charles River to the vicinity of the Cottage Farm Bridge. From there the combined sewage flows are carried northeast across the Mystic River through the North Metropolitan Trunk Sewer, and through the North Metropolitan Relief Tunnel for treatment at the Deer Island Plant and discharge into the ocean. During storm periods, when the Cambridge Branch Sewer flows at capacity, the tributary local sewers overflow to the Charles River at 13 relief points above the Cottage Farm Bridge and at four relief points between the Cottage Farm Bridge and the Charles River Dam.

The Charles River Valley Sewer serves sections of Waltham, Watertown, Newton, the Allston-Brighton section of Boston and Brookline. It originates near the Newton-Waltham line and parallels the south bank of the Charles River to St. Mary's Street in Brookline. It then flows southeast to the Ward Street Headworks and through the Boston Main Drainage Tunnel to the Deer Island Treatment Plant. Along the route of the Charles River Valley Sewer there are 14 overflow relief points which discharge to the Charles River upstream of the Cottage Farm Bridge.

The Brookline Sewer serves the area of Brookline below the Brighton Branch Sewer. The Brookline Sewer joins the Charles River Valley sewer through a regulator at Commonwealth Avenue and St. Mary's Street. Excess flow at this point is discharged through a relief sewer to the Charles River.

The sewer systems of the largest communities tributary to the Charles River Valley Sewer System are largely combined. Boston and Cambridge are the major sources of combined sewage flows. Since the construction of the Cottage Farm Station the town of Brookline has embarked on a separation program. Other contributing communities such

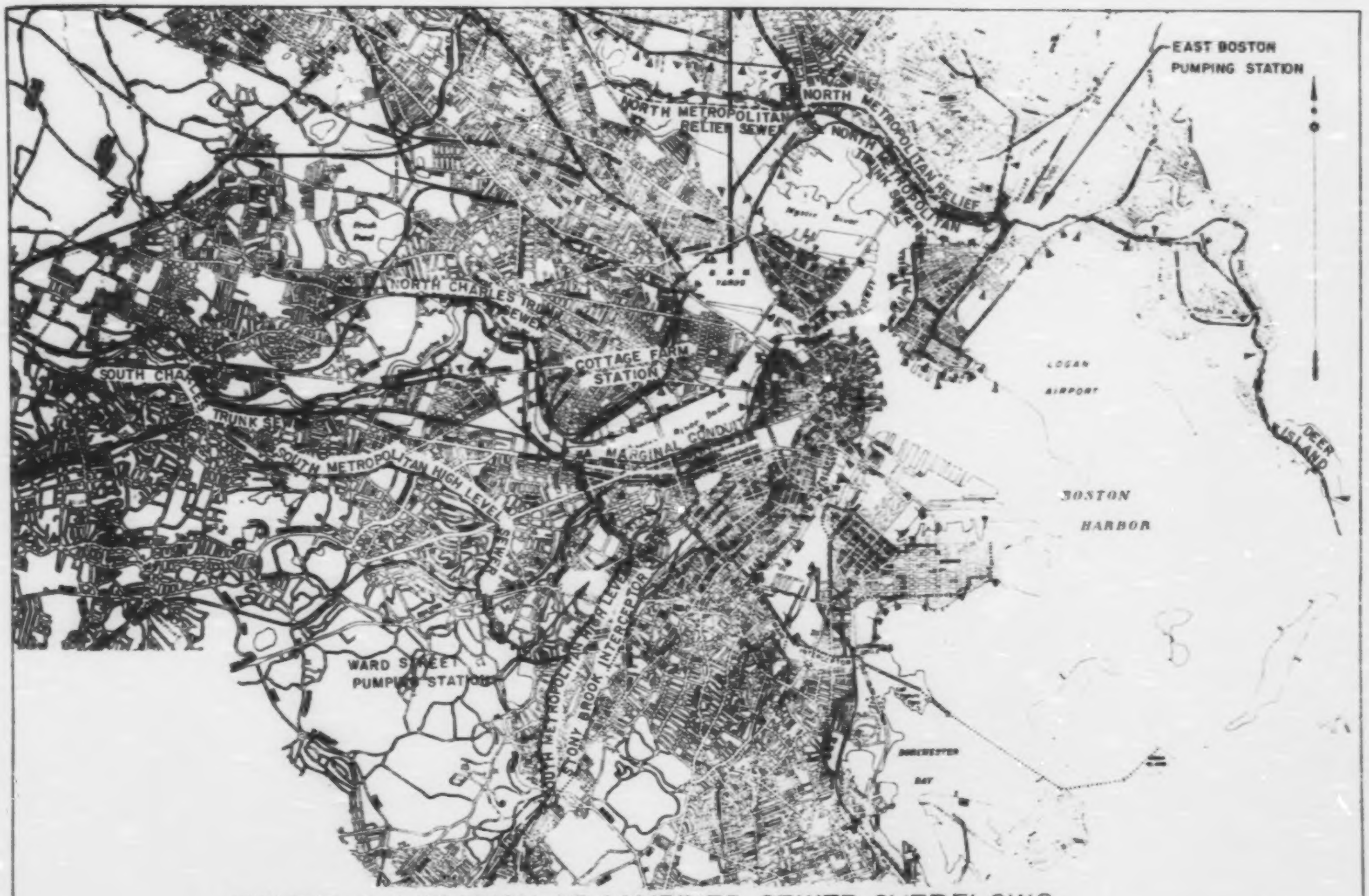

EAST BOSTON
PUMPING STATION
NORTH METROPOLITAN RELIEF SEWER
NORTH METROPOLITAN
NORTH METROPOLITAN RELIEF
NORTH METROPOLITAN TRUNK SEWER
Mystic River
NORTH CHARLES TRUNK SEWER
COTTAGE FARM STATION
SOUTH CHARLES TRUNK SEWER
MARGINAL CONDUIT
SOUTH METROPOLITAN HIGH LEVEL SEWER
STONY BROOK INTERCEPTOR
SOUTH METROPOLITAN HIGH LEVEL
WARD STREET
PUMPING STATION
LOGAN
AIRPORT
DEER
ISLAND
BOSTON
HARBOR
DORCHESTER
BAY

FIGURE 4. LOCATION OF COMBINED SEWER OVERFLOWS.

as Newton, Belmont, Waltham and Watertown have, for the most part, separate sanitary and storm drainage systems. However, flows from these communities increase during periods of rainfall due to illegal drain connections and infiltration.

The Charles River Valley and Cambridge Branch Sewers were intended to carry peak sanitary sewage flows plus a limited volume of storm water. During storm periods, the sewers could handle only a small fraction of the aggregate flow carried to them by the tributary sewers. As a result, the capacity of the interceptors was quickly surpassed by almost every storm, and combined sewage discharged to the Charles River at 27 relief points above the Cottage Farm Bridge. Much of the sanitary sewage from the separated sections of upstream communities also overflowed to the river during storm periods due to the numerous cross-connections between the combined and sanitary sewers.

Although some efforts are being made to install separate storm and sanitary sewers in areas presently served by combined sewers, complete separation of all areas is unlikely due to the excessive economic and social costs involved. All new construction includes separate storm and sanitary systems; however these will continue to discharge to combined lateral and trunk sewers for the foreseeable future. Accordingly, large and frequent overflows of combined sewage would have continued to discharge into the Charles River, if the Metropolitan District Commission's comprehensive program to provide additional sewer capacity and overflow treatment facilities had not been developed and implemented.

Relief Sewers

The Metropolitan District Commission's comprehensive plan to improve water quality in the Charles River Basin and Boston Harbor includes the construction of new relief sewers to provide additional capacity for both the North and South Charles sewer systems. When construction is completed, flows up to 2.1 times the projected 1985 dry weather flow will be carried to Deer Island for treatment. Flows in excess of this amount will be treated at the Cottage Farm Station and discharged to the Charles River. The relief sewers and the Cottage Farm Station are indicated in Figure 5. Table 1 indicates the storm runoff factors assumed for design of these relief sewers.

The North Charles Relief Sewer, now under construction, will be 11,350 feet long and will drain approximately 1,755 acres. It will begin at Lowell Street in Cambridge and parallel the existing Cambridge Branch Sewer to the Cottage Farm Bridge. The North Charles Relief Sewer will receive flows from the Cambridge Sewer to relieve all 13 overflow points upstream of the Cottage Farm Bridge. The combined design capacity of these two sewers will be 157 mgd at the Cottage Farm Station, approximately seven (7) times the estimated 1985 dry weather flow.

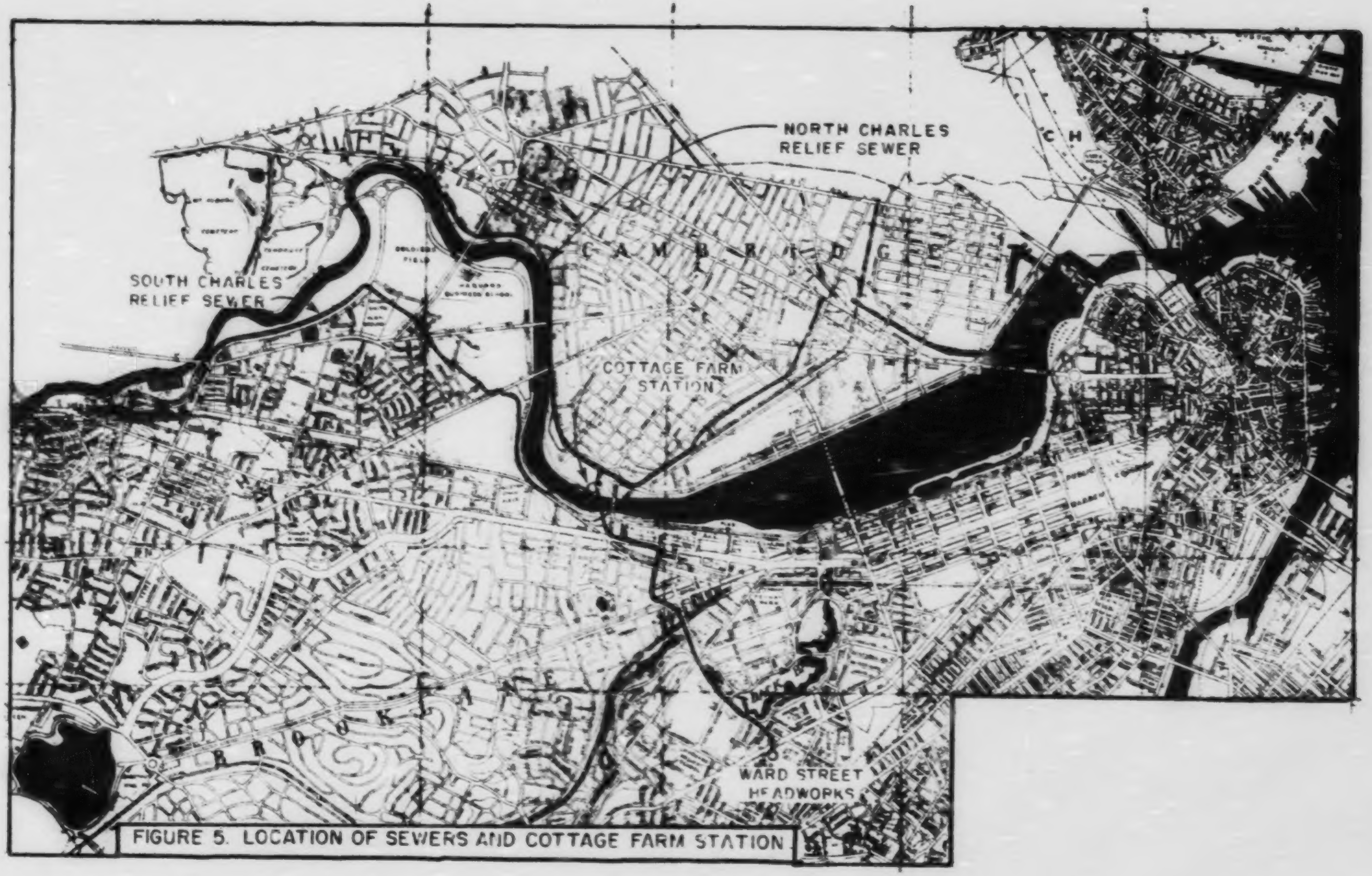

NORTH CHARLES RELIEF SEWER
SOUTH CHARLES RELIEF SEWER
CAMBRIDGE
COTTAGE FARM STATION
BROOKLINE
WARD STREET HEADWORKS

FIGURE 5. LOCATION OF SEWERS AND COTTAGE FARM STATION

Table 1. STORM RUNOFF FACTORS ASSUMED FOR DESIGN OF RELIEF SEWERS

System	Tributary Area (Acres)	Percent of Tributary Area served by Combined or Partly Combined Sewers	Time of Concentration (hrs.)	Runoff Coefficent
South Charles Relief Sewer	13,400	12%	3.0	0.014
North Charles Relief Sewer	1,755	71%	1.5	0.20
Main Street Relief Sewer	445	32%	1.0	0.113
	15,600			

The section of the relief sewer already completed has connected seven overflows to the Cottage Farm Station. The Cambridge Branch Sewer flows into the North Charles Relief Sewer just upstream of the Cottage Farm Station.

The North Charles Relief Sewer will also receive up to 29 mgd from the 5,870 foot long relief sewer now under construction between the Cottage Farm Bridge and Main Street in Cambridge. The section of the Cambridge Branch Sewer which flows east and serves this area will be abandoned. The new relief sewer will pick up the four overflows from the Cambridge Branch Sewer to the Charles River downstream of the Cottage Farm Bridge.

The South Charles Relief Sewer begins at the Newton-Waltham line and runs approximately parallel to the CharlesRiver Valley Sewer to the Cottage Farm Bridge. This sewer was completed in 1967. All 14 overflows along the route of the Charles River Valley Sewer are picked up by the South Charles Relief Sewer. The relief sewer is approximately 35,190 feet in length and drains 13,480 acres. It has a design capacity at the Cottage Farm Bridge of 125 mgd, approximately four (4) times the estimatdd 1985 dry weather flow. The Charles River Valley Sewer is not connected to the Cottage Farm Station but joins the trunk to the Ward Street Headworks and flows directly to the Deer Island Treatment Plant. The higher ratio of capacity to 1985 dry weather flow for the North Charles system reflects the more highly combined nature of its tributary area.

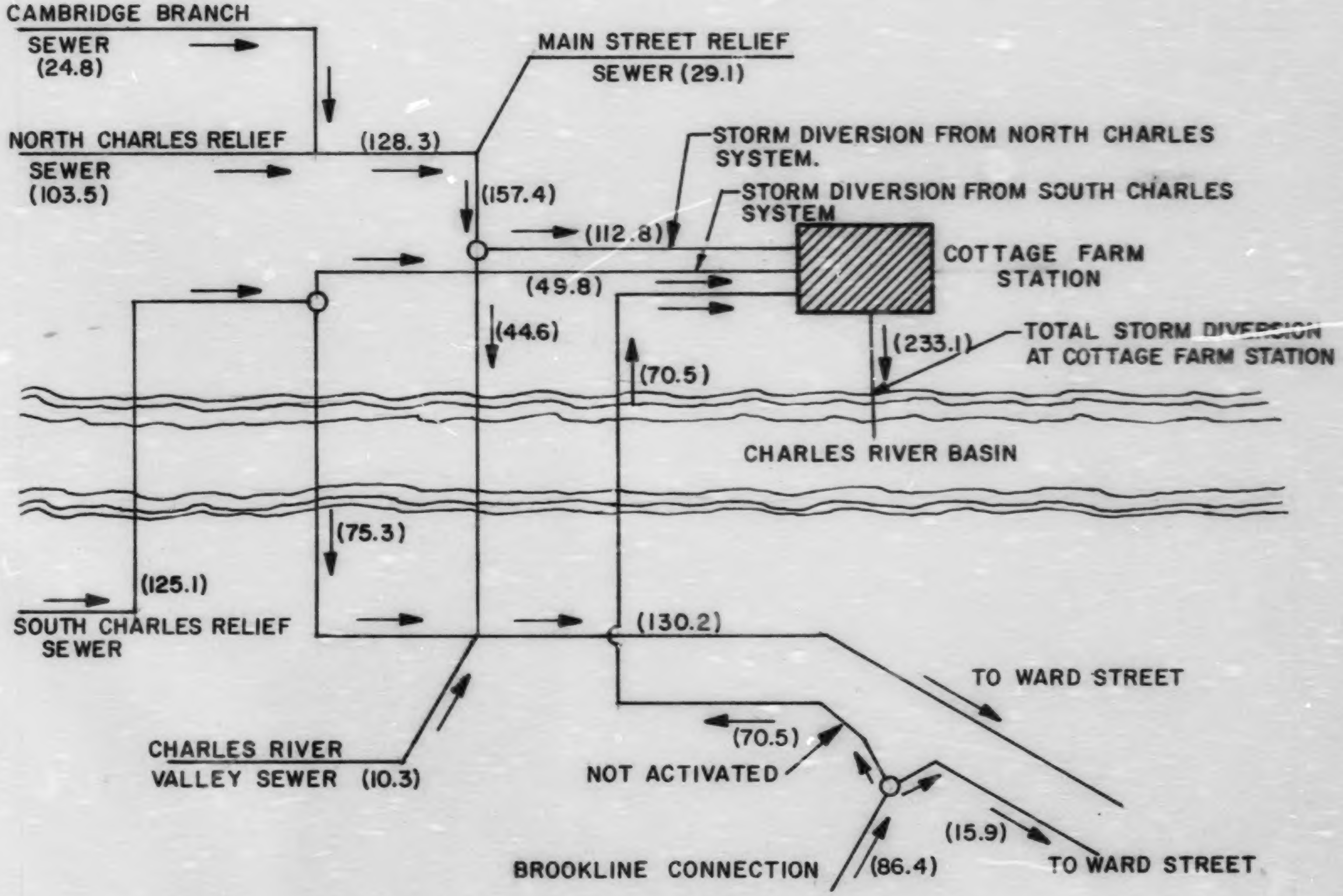
The comprehensive plan also included the diversion of 70.5 mgd from the Brookline Sewer to the Cottage Farm Station. However, the Town of Brookline has since separated their sewer system and this diversion has never been activated.

DESIGN FLOWS AT THE COTTAGE FARM BRIDGE

The design capacity of the entire Charles River SEWER System at the Cottage Farm Bridge, where the North and South Charles sewer systems converge is 379 mgd. The sizes and design flows of these sewers are listed in Table 2 and illustrated in Figure 6. Flows less than 146 mgd, that is, less than 2.1 times the estimated 1985 average dry weather flow, are carried by the trunk sewer to the Ward Street Headworks, and then to the Deer Island Treatment Plant. Flows in excess of 146 mgd are diverted to the Cottage Farm Station. The Cottage Farm Station was expected to be activated about 22 times per year. Overflows to the Charles River from the sewers upstream of the Cottage Farm Bridge occur only when the relief sewers are surcharged, an occurrence with an estimated frequency of not more than once in

Table 2. Sewer Sizes and Design Flows

Sewer	Upstream of Cottage Farm Size (in)	Design Flow (mgd)	Flow to Ward St. Headworks Size (in)	Design Flow (mgd)	Diversion to Cottage Farm Size (in)	Design Flow (mgd)
Cambridge Branch Sewer	44 x 50	24.8				
Main Street Relief Sewer	60	29.1				
North Charles Relief Sewer before Junction	73½ x 98	103.5				
North Charles Relief Sewer after Junction	88 x 138	157.4	60	44.6	72	112.8
Charles River Valley Sewer	60	10.3	60	10.3		
South Charles Relief Sewer	88 x 117½	125.1	72	75.3	42	49.8
Trunk to Ward Street Headworks			108	130.2		
Total Design Flows		292.8		130.2		162.6
Brookline Sewer	84 x 89	86.4	66	15.9	54	70.5
Design Total				146.1		233.1


CAMBRIDGE BRANCH
SEWER
(24.8)
NORTH CHARLES RELIEF
SEWER
(103.5)
(128.3)
MAIN STREET RELIEF
SEWER (29.1)
(157.4)
(112.8)
STORM DIVERSION FROM NORTH CHARLES SYSTEM.
STORM DIVERSION FROM SOUTH CHARLES SYSTEM
COTTAGE FARM STATION
(49.8)
(44.6)
(70.5)
(233.1)
TOTAL STORM DIVERSION AT COTTAGE FARM STATION
CHARLES RIVER BASIN
(75.3)
(125.1)
SOUTH CHARLES RELIEF
SEWER
(130.2)
TO WARD STREET
CHARLES RIVER
VALLEY SEWER (10.3)
(70.5)
NOT ACTIVATED
(15.9)
BROOKLINE CONNECTION
(86.4)
TO WARD STREET

(FIGURES IN PARENTHESES ARE DESIGN STORM MGD)

FIGURE 6. SCHEMATIC OF THE CHARLES RIVER VALLEY SEWER SYSTEM.

five years. When the sewers are flowing full, the capacity at the Cottage Farm Bridge is 458.6 mgd.

PLANS CONSIDERED FOR DISPOSAL OF THE FLOW DIVERTED AT THE COTTAGE FARM BRIDGE

Three alternative plans for the disposal of the combined sewage flows diverted at the Cottage Farm Bridge were considered:

1) Screening at the Cottage Farm Bridge site and pumping through a new force main to tidewater below the Charles River Dam.

2) Diversion only at the Cottage Farm Bridge site, plus a new gravity flow interceptor to the Charles River Dam site, where the flows would be screened (along with flows from the Boston Marginal Conduit) and pumped to tidewater.

3) Screening, chlorination and detention at the Cottage Farm Bridge site and discharge to the Charles River.

The costs of completely separating the sewers in the combined sewered areas were also investigated. For the City of Cambridge, the cost of separating the lateral and trunk sewers was estimated to be $50,000,000 with an additional $50,000,000 necessary for work on private property such as the separation of roof and yard drains. Since the facility was designed, the City of Cambridge has undertaken a partial separation program to remove street runoff from the combined system in some areas.

Although the first two alternatives would have removed the combined sewage discharges due to storms smaller than the five-year design storm from the Charles River Basin, they required construction of over 2.6 miles of piping and discharge without chlorination or settling to the already badly polluted Boston Inner Harbor. The projected cost of Alternative 1 was 1.7 times the cost of Alternative 3; Alternative 2 was 2.6 times greater, although only Alternative 2 included pumping and screening of the flows from the Boston Marginal Conduit.

The selected plan, Alternative 3, will provide the following protection to the Charles River Basin:

1) Up to 1.3 million gallons of each storm will be retained in the detention tanks and returned to the sewer system as capacity in the trunk sewer to the Ward Street Headworks becomes available.

2) Minor storms will not discharge to the river at all.

3) Discharge will be infrequent, and will occur at times of maximum dilution by the receiving waters.

4) The volume discharged will be small relative to basin volume and inflow.

5) The discharge is located at a point where the channel is narrow so maximum mixing with the receiving water will occur.

6) Oxygen concentrations are not a problem during periods when overflows will occur.

7) Stratification problems in the basin will be ameliorated by the construction of the new Charles River Dam.

8) Floating material will be removed by screening and skimming.

9) The effluent will be chlorinated to minimize public health hazards associated with the discharge of combined sewage.

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SECTION IV

DESIGN AND CONSTRUCTION OF THE COTTAGE FARM DETENTION CHLORINATION STATION

DESIGN STUDY OF FREQUENCY, VOLUME AND DURATION OF FLOWS DIVERTED TO THE COTTAGE FARM DETENTION AND CHLORINATION STATION

Using rainfall records from the National Weather Service station at Logan Airport, the design study projected the frequency, duration and volume of combined sewage flows to be diverted to the Cottage Farm Station.

It was estimated that a rainfall intensity of 0.14 inches per hour (0.36 cm/hr) for three-hour duration, or 0.22 inches per hour (0.56 cm/hr) for one-hour duration would cause flows from the North Charles Relief Sewer to be diverted to the Cottage Farm Station. It was estimated that 2.5 percent of the storms over a five year period would produce a maximum overflow rate greater than 233.1 mgd, the design capacity of the Cottage Farm Station and one percent would have an average overflow rate greater than 233.1 mgd. An average of 6.3 million gallons of combined sewage was expected to be diverted to the Cottage Farm Station each storm.

Diversions to theCottage Farm Station were expected to occur an average of twenty-two (22) times per year. Based on an average duration of 4.6 hours per storm it was anticipated that the facility would operate 100 hours a year. As a maximum limit, it was not expected that the overflows would occur more than 50 times per year for about 6-hours duration, or about 300 hours in an average year. A comparison of expected to actual operating results is given in Table 6, page 43.

DESCRIPTION OF THE COTTAGE FARM DETENTION AND CHLORINATION STATION

General

During a rainstorm, when the flows in the North and South Charles Relief Sewers reach their respective capacities downstream of the Cottage Farm Station, the excess combined sewage is diverted to the Cottage Farm Station (See Figure 6). The overflow from the relief sewers enters the screen chamber and passes through the coarse and fine bar screens before it enters the wet well. The flow is pumped from the wet well to the detention tank influent channel, where it is chlorinated. The flow then enters the detention tanks where it is skimmed and settled and discharged through fine mesh screens to the Charles River via a submerged multiple outlet outfall. Plan and profile views of the Cottage Farm Detention and Chlorination Station are shown in Figures 7, 8, and 9. Figure 10 gives a schematic of the plant components. The following paragraphs discuss the components of the Cottage Farm Station in more detail. Some of the specifications are summarized in Table 3.

Diversion of Excess Combined Sewage Flows

The excess flows from the relief sewers enter a bellmouth inlet structure which is separated from the Cottage Farm Station by three 72-inch sluice gates. This structure was designed so that these sluice gates would remain closed until the liquid level in the inlet structure reached 14 inches, at which point contact would be made with a probe and the gates would open. In operation, one of the sluice gates is left open several inches to allow the small flows which splash over the weirs or seep into the pipes to enter the wet well directly without activating the station.

Screening Facilities

As the flow enters the Cottage Farm Station it is directed into three channels, each designed to handle 120 mgd. (see Figure 8). In each channel the flow passes through a coarse bar screen and a fine bar screen before entering the wet well. A small sampling pump diverts a portion of screened influent just after the fine screens. An automatic sampler periodically samples this flow into 100 ml vials which are stored in a refrigerated compartment for subsequent analysis.

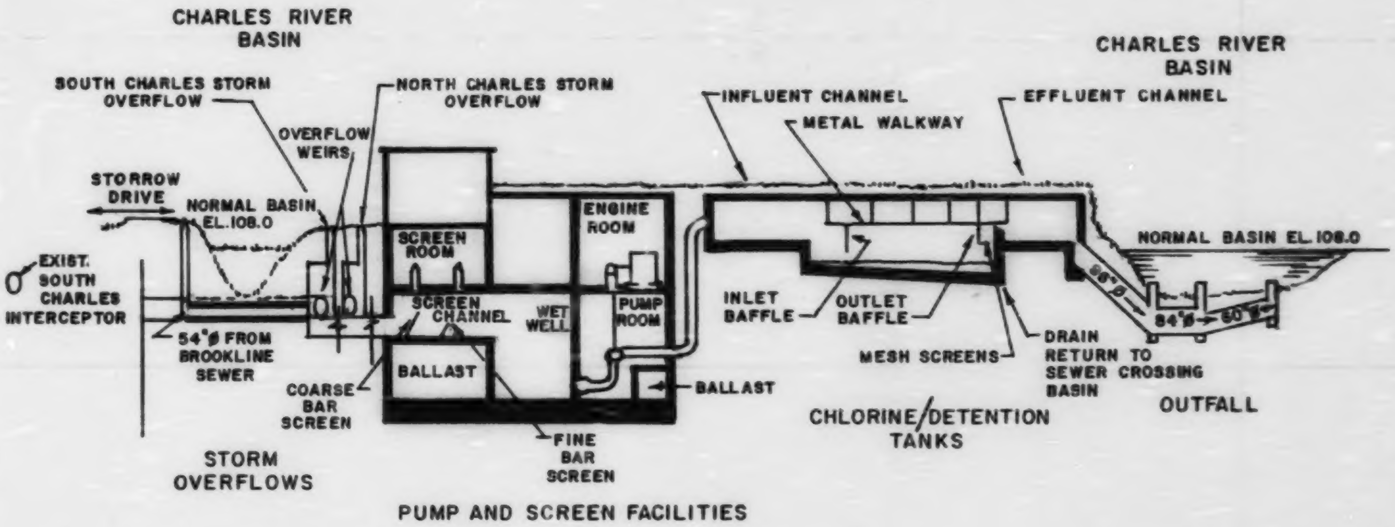
CHARLES RIVER BASIN
SOUTH CHARLES STORM OVERFLOW
NORTH CHARLES STORM OVERFLOW
OVERFLOW WEIRS
STORROW DRIVE
NORMAL BASIN EL.108.0
EXIST. SOUTH CHARLES INTERCEPTOR
54"⌀ FROM BROOKLINE SEWER
COARSE BAR SCREEN
SCREEN ROOM
SCREEN CHANNEL
WET WELL
ENGINE ROOM
PUMP ROOM
BALLAST
BALLAST
FINE BAR SCREEN
STORM OVERFLOWS
PUMP AND SCREEN FACILITIES
CHARLES RIVER BASIN
INFLUENT CHANNEL
METAL WALKWAY
EFFLUENT CHANNEL
INLET BAFFLE
OUTLET BAFFLE
MESH SCREENS
DRAIN RETURN TO SEWER CROSSING BASIN
CHLORINE/DETENTION TANKS
NORMAL BASIN EL. 108.0
96"⌀
84"⌀
60"⌀
OUTFALL

FIGURE 7. PROFILE VIEW—COTTAGE FARM STATION.

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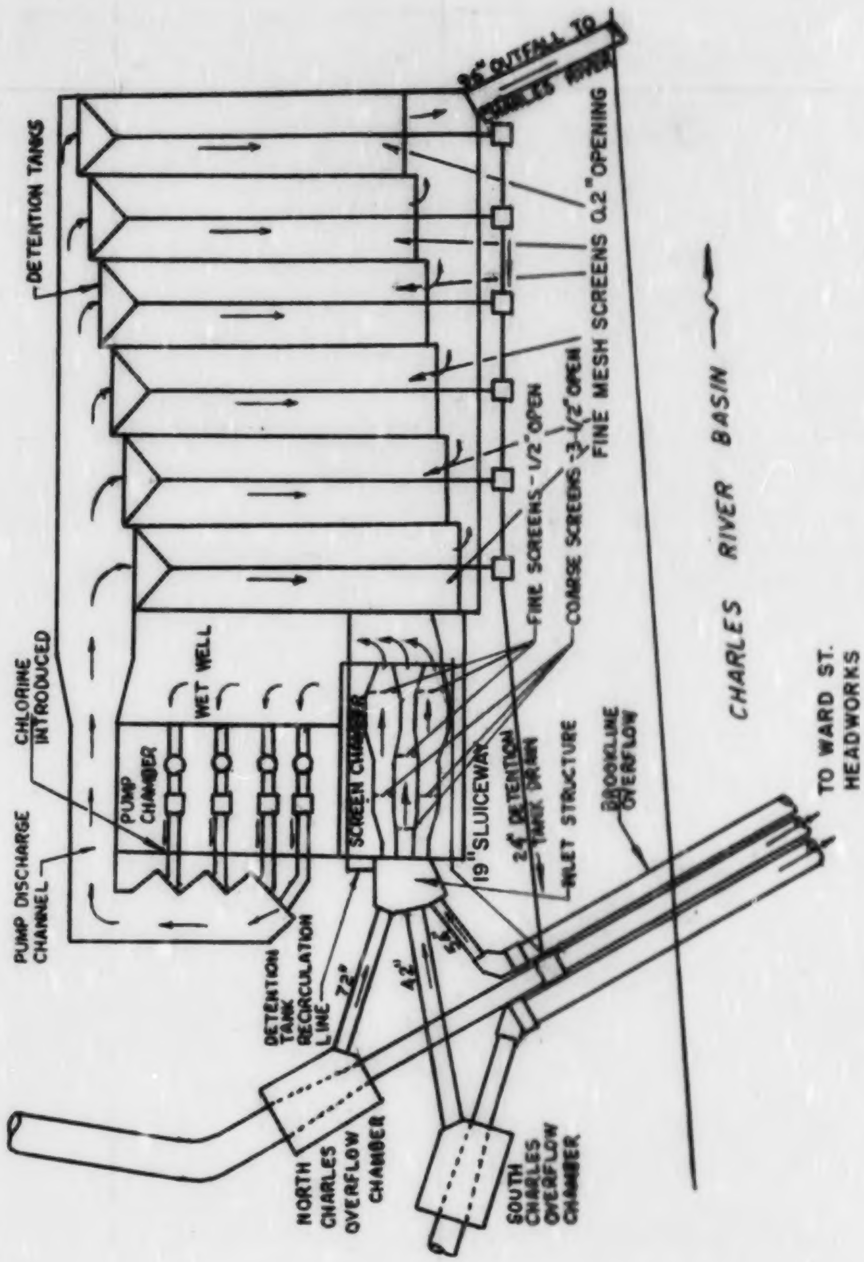
DETENTION TANKS
96" OUTFALL TO CHARLES RIVER
FINE MESH SCREENS 0.2" OPENING
FINE SCREENS - 1/2" OPEN
COARSE SCREENS - 3-1/2" OPEN
CHLORINE INTRODUCED
WET WELL
PUMP DISCHARGE CHANNEL
PUMP CHAMBER
SCREEN CHAMBER
19" SLUICEWAY
24" DETENTION TANK DRAIN
INLET STRUCTURE
BROOKLINE OVERFLOW
CHARLES RIVER BASIN
TO WARD ST. HEADWORKS
DETENTION TANK RECIRCULATION LINE
72"
42"
56"
NORTH CHARLES OVERFLOW CHAMBER
SOUTH CHARLES OVERFLOW CHAMBER

FIGURE 8. PLAN VIEW – COTTAGE FARM STATION.

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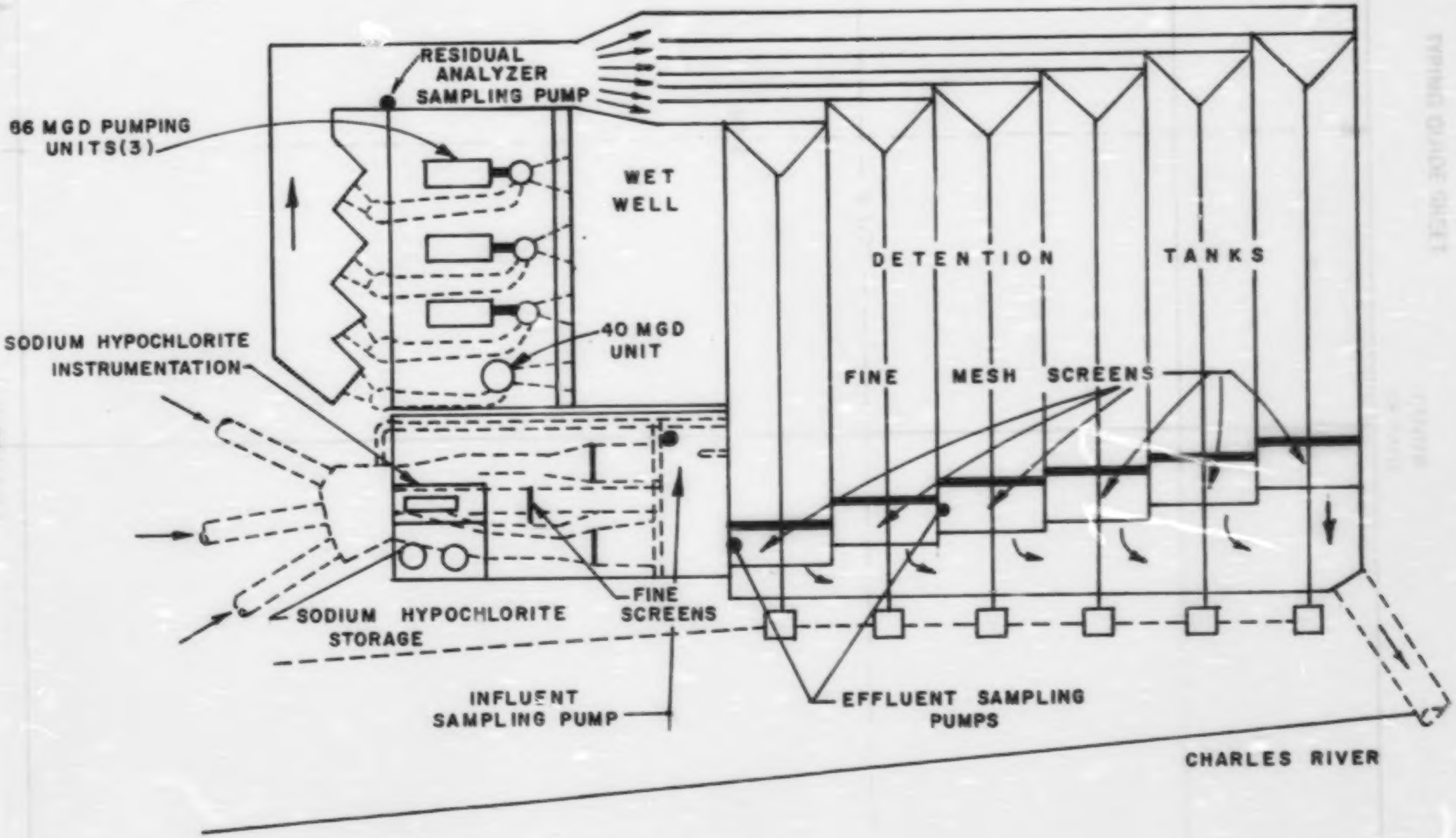
RESIDUAL
ANALYZER
SAMPLING PUMP
66 MGD PUMPING
UNITS(3)
WET
WELL
DETENTION
TANKS
40 MGD
UNIT
SODIUM HYPOCHLORITE
INSTRUMENTATION
FINE
MESH
SCREENS
SODIUM HYPOCHLORITE
STORAGE
FINE
SCREENS
INFLUENT
SAMPLING PUMP
EFFLUENT SAMPLING
PUMPS
CHARLES RIVER

FIGURE 9. FLOOR PLAN OF EQUIPMENT.

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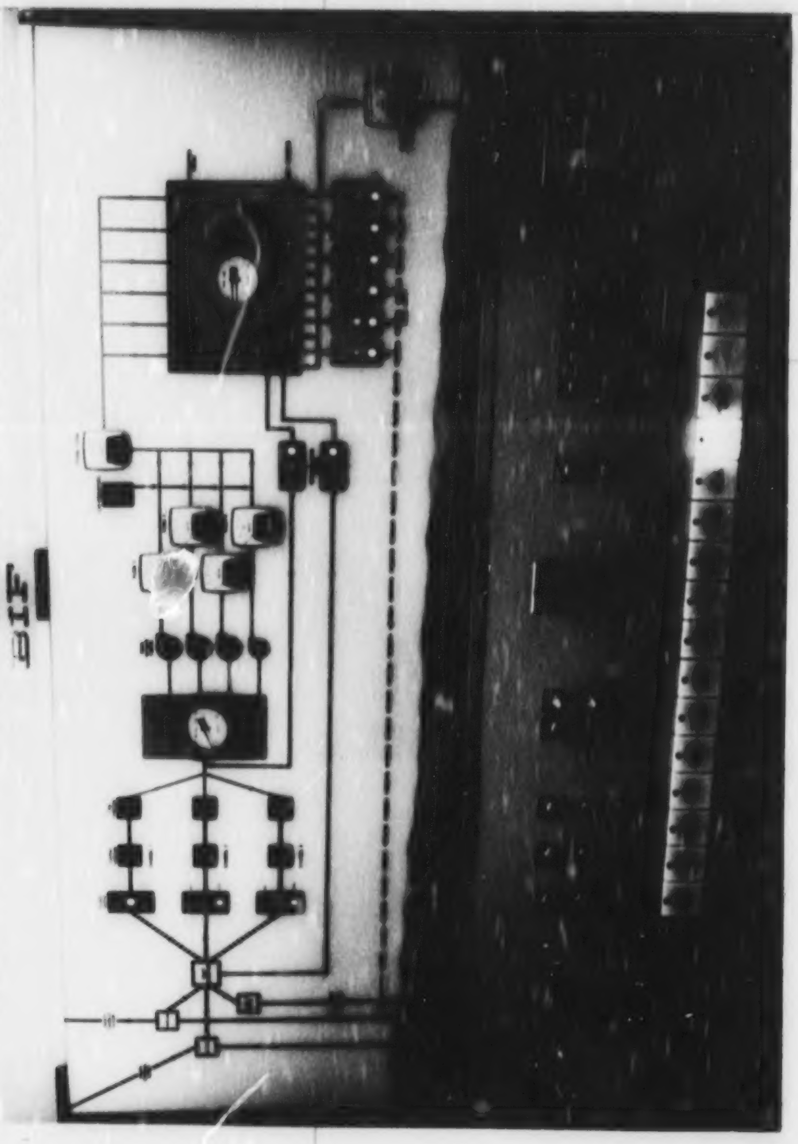

Figure 10. Graphic Control Panel

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Table 3. Summary of Specifications

	South Charles Relief Sewer	North Charles Relief Sewer
Towns served	Weston, Waltham, Watertown, Newton, Boston, Brookline	Belmont Cambridge
Drainage area (acres)	13,400	1,090
Capacity upstream of Cottage Farm - design (mgd)	125	157
Capacity downstream of Cottage Farm - design (mgd)	75	44
Design capacity to 1965 Dry Weather Flow ratio-		
upstream of Cottage Farm	4	7
downstream of Cottage Farm	2.1	2.1
Number of overflows connected	14	7
Number of overflows to be connected in the future	0	10
Cost of relief sewer construction to date	$12,800,000	$ 7,193,000
Estimated cost of relief sewer construction remaining	$ 0	$10,000,000
	Chlorination and Detention Station	
Normal Charles River Basin Elevation (MDC base*)	108.0	
Finished grade - parking area	113.75	
Finished grade above detention tanks	124.5	
Height of main superstructure above el. 113.75	20.4 ft	
Depth of wet well floor below el. 113.75	45.75 ft	
Depth of pump pit floor below el. 113.75	46.75 ft	
Length of Cottage Farm Station	254 ft	
Width of Cottage Farm Station	140 ft	
Volume of wet well (max)	0.35 mg	
Total detention tank volume (6 tanks)	1.2 mg	
Capacity of electric pump	45 mgd	
Capacity of the 3 diesel pumps, each	85.5 mgd	
Clear spacing between bars of coarse screens	3.5 in	
Clear spacing between bars of fine screens	0.5 in	
Clear spacing of fine mesh screens	0.2 in	
Total Construction cost	$4,051,961	

*Elevation 0.0, MDC base, is 106.62 feet below mean sea level

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The coarse and fine screens (See Figure 11) are of the catenary type and have clear openings of 3.5 inches (8.9 cm) and 0.5 inches (1.3 cm) respectively. The spacing of the fine bar screens is smaller than that customarily used in sewage treatment plants as these screens are used to maximize the removals of floatables as well as to protect pumps and other equipment. The maximum removal of floating solids is one of the major treatment objectives of this facility, so the smallest practicable clean opening was chosen to prevent solids from passing through the facility to the Charles River Basin.

Both the coarse and fine bar screens are mechanically cleaned. The fine bar screenings are dropped into an 18-inch sluiceway by the rakes. The sluiceway is flushed with 400-1600 gpm of screened sewage pumped by stripping pumps located in the wet well. The sluiceway returns the screenings to the North Charles Relief Sewer downstream from the Station. Returning the screenings to the downstream sewer flow for treatment at Deer Island was chosen as the disposal method because the relatively small quantity of screenings and the intermittent operation of the facility could not justify the additional cost of storage and loading facilities necessary for trucking screenings to a suitable disposal site.

The quantity of coarse screenings is substantially smaller than the fine screen removals, and may contain larger material such as boards which could become stuck in the sluiceway. These screenings are deposited in dumpsters and disposed of with the coarse screenings from the headworks facilities.

Pumping Equipment

From the screen chamber, influent enters the wet well. (See Figure 8). When the liquid level in the wet well reaches a depth of one foot (elevation 69.0, M.D.C. base)* it contacts a probe which activates the coarse and fine screens and one of the stripping pumps. The stripping pump provides a flow of screened wastewater to flush the fine screenings through the sluiceway. When the liquid level in the wet well reaches a depth of 14.5 feet, the electric motor-driven, 30-inch, 40 mgd pump starts automatically. This electrically driven pump provides flexible automatic operation at low overflow rates. If the level in the wet well continues to rise another foot, one of the three 42-inch, 86 mgd diesel-driven pumps starts up. (See Figure 12) The two other diesel driven pumps start up automatically at predetermined wet well elevations if the water level continues to rise. The electric pump shuts down when the first diesel pump starts up and comes on again only if the diesel pumps cannot handle the flow. Each pump varies its speed and pumping rate automatically depending on the water level in the wet well. (This describes the design for automatic operation. In practice, the automatic controls have not been maintained in operating condtion and most of the functions are achieved manually.)

*Elevation 0.0 MDC base is 105.62 feet below U.S. Coast and Geodetic Survey Mean Sea Level.

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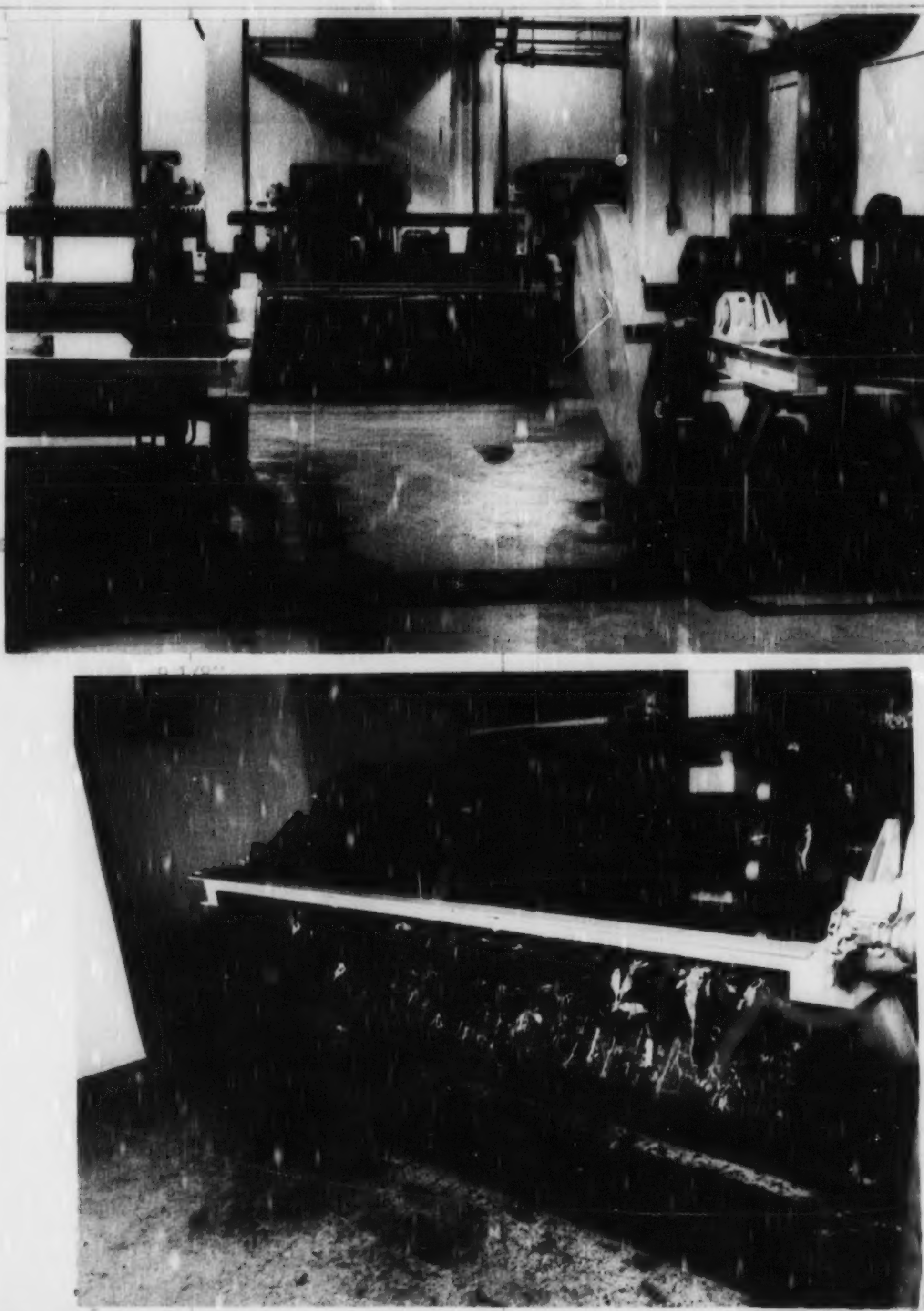

Figure 11. Screen Room and Sluiceway. Fine screens (3) in foreground, coarse screens (3) in rear (top); Fine screen with sluiceway in foreground (bottom).

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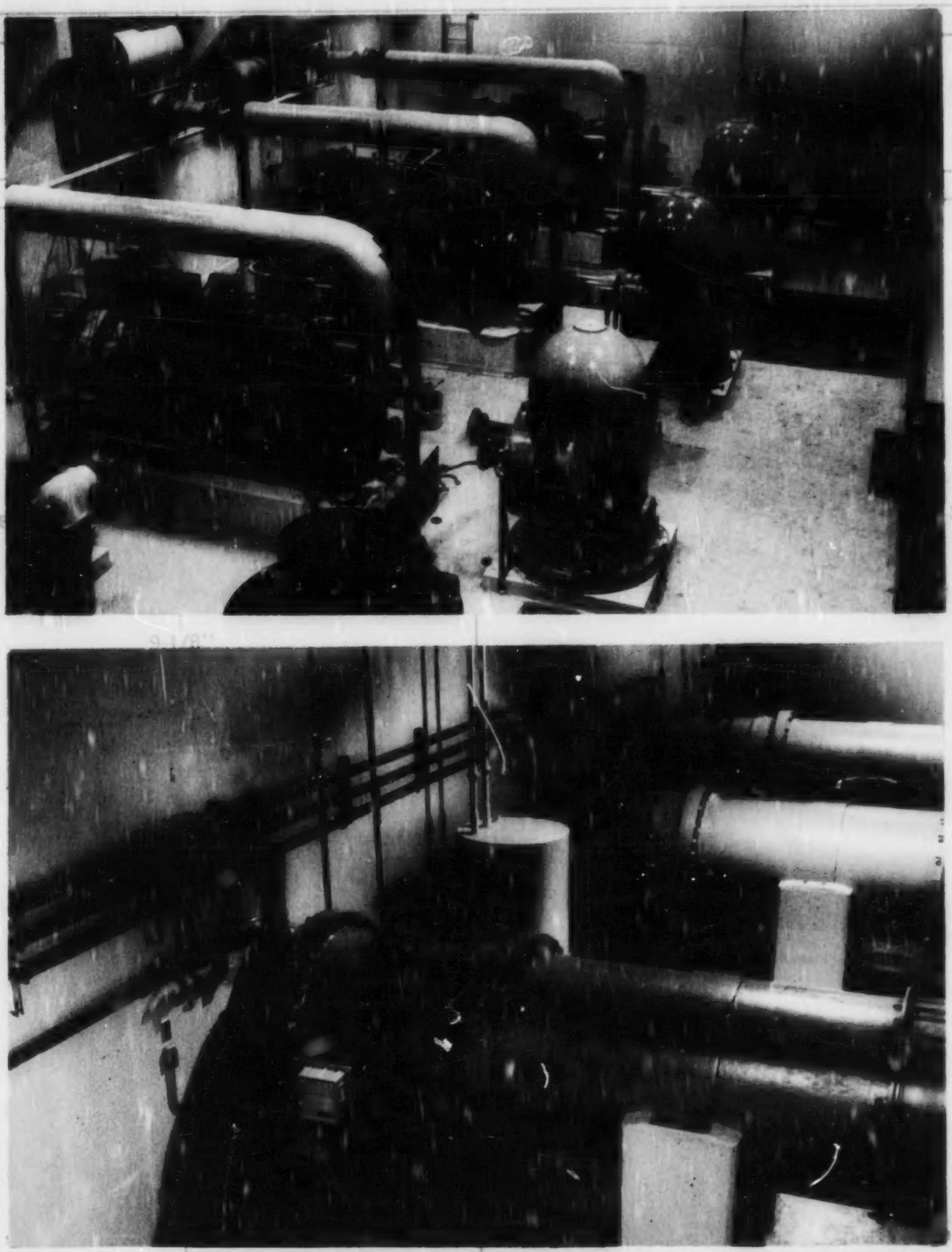

Figure 12. Engine Room and Pump Discharges. Engine room with electric engine in foreground (top); Pump discharges with hypochlorite feeders and Dall tube flow meters (bottom).

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Up to 90 percent of the design flow of 233 mgd can be handled with any one pump inoperative. With all four pumps running, the station can accomodate 298 mgd. The flows pumped by each pump are metered by a Dall tube and automatic chart recorder.

As the wet well level decreases, the pumps turn off one by one at predetermined elevations, until finally, at a water level of 10 feet (el. 78.0), the electric pump turns off. The stripping pump then empties the wet well to elevation 70.0. The final two feet of water are drained during the cleaning operations. The wet well volume below elevation 78.0 is approximately 100,000 gallons.

Chlorination

As each pump starts up automatically, a signal from the flow metering device (Dall tube) starts the sodium hypochlorite feeder for that pump. The 15 percent commercial sodium hypochlorite solution is automatically proportioned to the flow by roto-dip feeders and introduced into the discharge from the pumps (Figure 8). The dosage rate varies according to the strenght of the influent, from 2 mg/l to 4 mg/l of available chlorine.

From the pumps the flow is discharged into an open influent channel ahead of the detention tanks (Figure 8). About one-third of the way down this channel, a sampling pump provides a continuous sample for the chlorine residual analyzer. A controller is set to maintain the chlorine residual at 1 ppm and readjusts the sodium hypochlorite feed rate automatically as necessary.

The sodium hypochlorite solution is stored in two 4,200 gallon fiberglass tanks. The amount of hypochlorite required for the design storm was estimated to be 3,000 gallons. The amount sufficient for 80 percent of the storm incidents was estimated at 300 gallons per storm.

Detention Tanks

In the pump discharge channel the flow is divided into six channels which distribute the flow into the six detention tanks (Figures 13 and 14). Each channel is fitted with stop-log grooves so unneeded or inoperative tanks can be isolated. For small storms it would be advantageous to contain the flows in as few tanks as possible so unneeded tanks would not have to be cleaned. However, the stoplogs are not used at the Cottage Farm Station because they are to difficult to remove and replace during storm events for such operation. A baffle at the influent end of each detention tank dissipates entry turbulence and prevents short circuiting.

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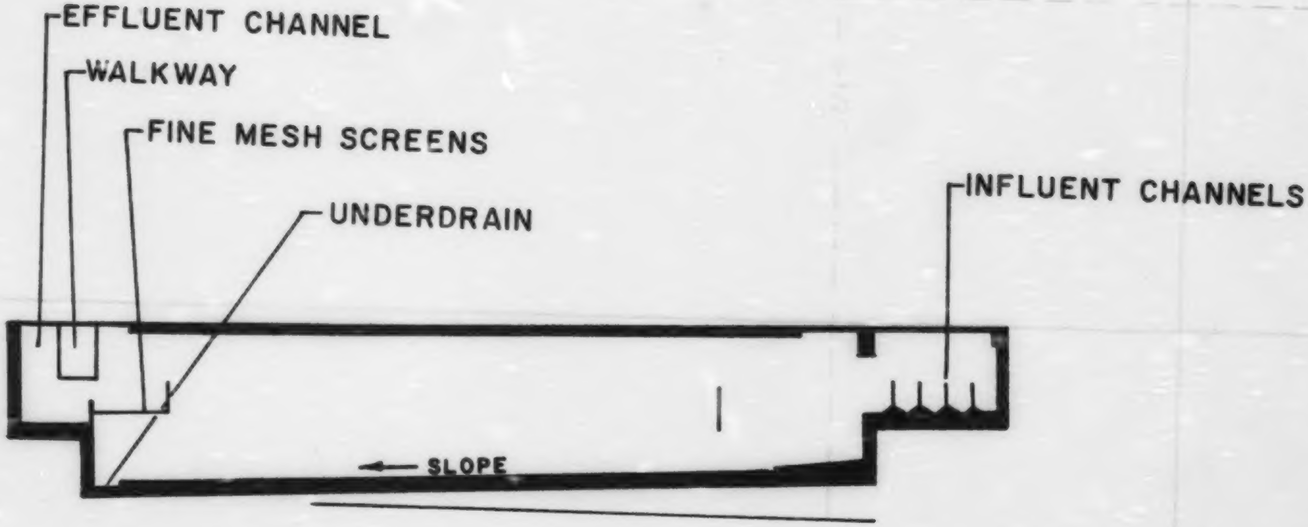
EFFLUENT CHANNEL
WALKWAY
FINE MESH SCREENS
UNDERDRAIN
INFLUENT CHANNELS
SLOPE

Figure 13. Detention Tank Profile

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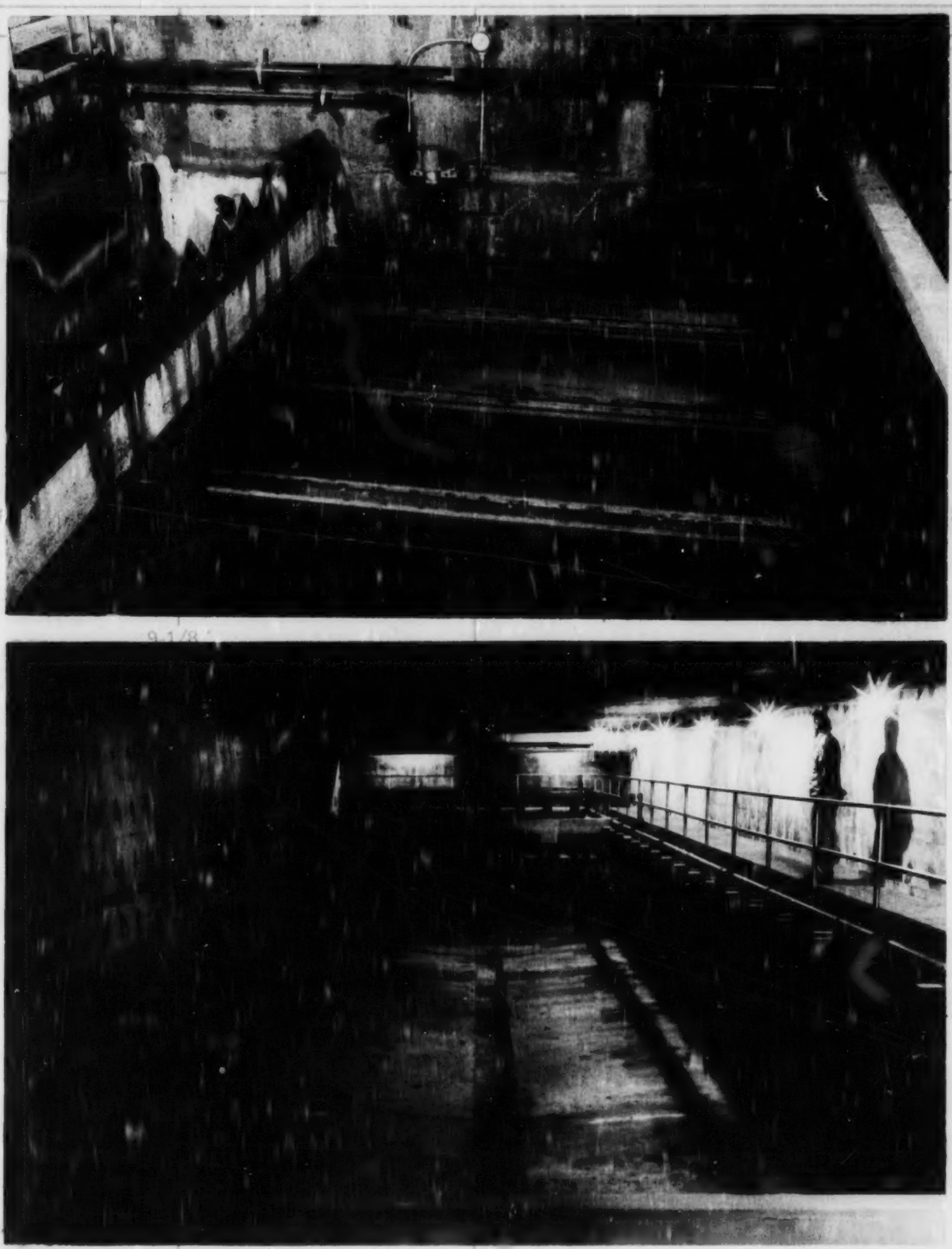

Figure 14. Fine Mesh Screens and Detention Tank Influent. Fine mesh screens with effluent baffle, overflow weir and overflow channel (top); Detention tank looking toward influent baffle and influent channels (bottom).

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The overflow from each tank flows under a baffle (to retain floating material) and then upward through submerged horizontal wire mesh screens. The use of fine mesh screens with 0.2 inch (0.5 cm) openings at the effluent end of each detention tank is an innovation in this facility. The solids are trapped on the underside of the screen and are easily washed off during the clean-up after each activation (Figure 15). The screens are hinged to allow them to swing open (upward), if they become excessively clogged, to let the flow past without damaging the screens.

The total capacity of the detention tanks is 1,200,000 gallons. At the design flow of 233 mgd the chlorine contact time is eight minutes in the detention tanks and two minutes in the outfall. The total contact time was expected to exceed 30 minutes for 80 percent of the station activations. Solids are removed through settling in the detention tanks.

Overflows to the Charles River occur only after the 1,200,000 gallon storage capacity of the six detention tanks is exceeded. It was estimated that about 15 percent of all diversions to the station would be contained in the detention tanks and would not discharge to the Charles River. Overflows from the detention tanks discharge by gravity through a 96-inch subaqueous outfall with three outlet ports approximately 12 feet below the water surface (Figure 7). Two sampling pumps, both ahead of the fine mesh screens, one at the effluent end of detention tank 3 and the other in detention tank 6, take samples of the chlorinated effluent.

At the end of each activation, the detention tanks are dewatered through a drain at the bottom of each tank. The contents are returned to the North Charles Relief Sewer to be transported to the Deer Island Treatment Plant. It takes approximately one hour to drain the detention tanks.

The screen channels are cleaned by draining part of the contents of the first detention tank to the inlet structure so that it flows through the screen channels into the wet well. The wet well is pumped out by stripping pumps into the North Charles Relief Sewer. Fixed spray nozzles in the detention tanks and pump discharge channel are used to wash down the walls and flush the accumulated sludge and skimmings to the sewer. A maintenance crew then washes down the detention tanks, pump discharge channel, wet well, and screen room with fire hoses. The water for the cleanup operations is provided by an on-site well.

A ventilation system exhausts air from the detention tanks, wet well and screen room through activated carbon cannisters to prevent odor problems in the surrounding area. The absence of odor problems, however, and the cost of replacement canisters have led to a policy of not replacing them, at least until some problem arises.

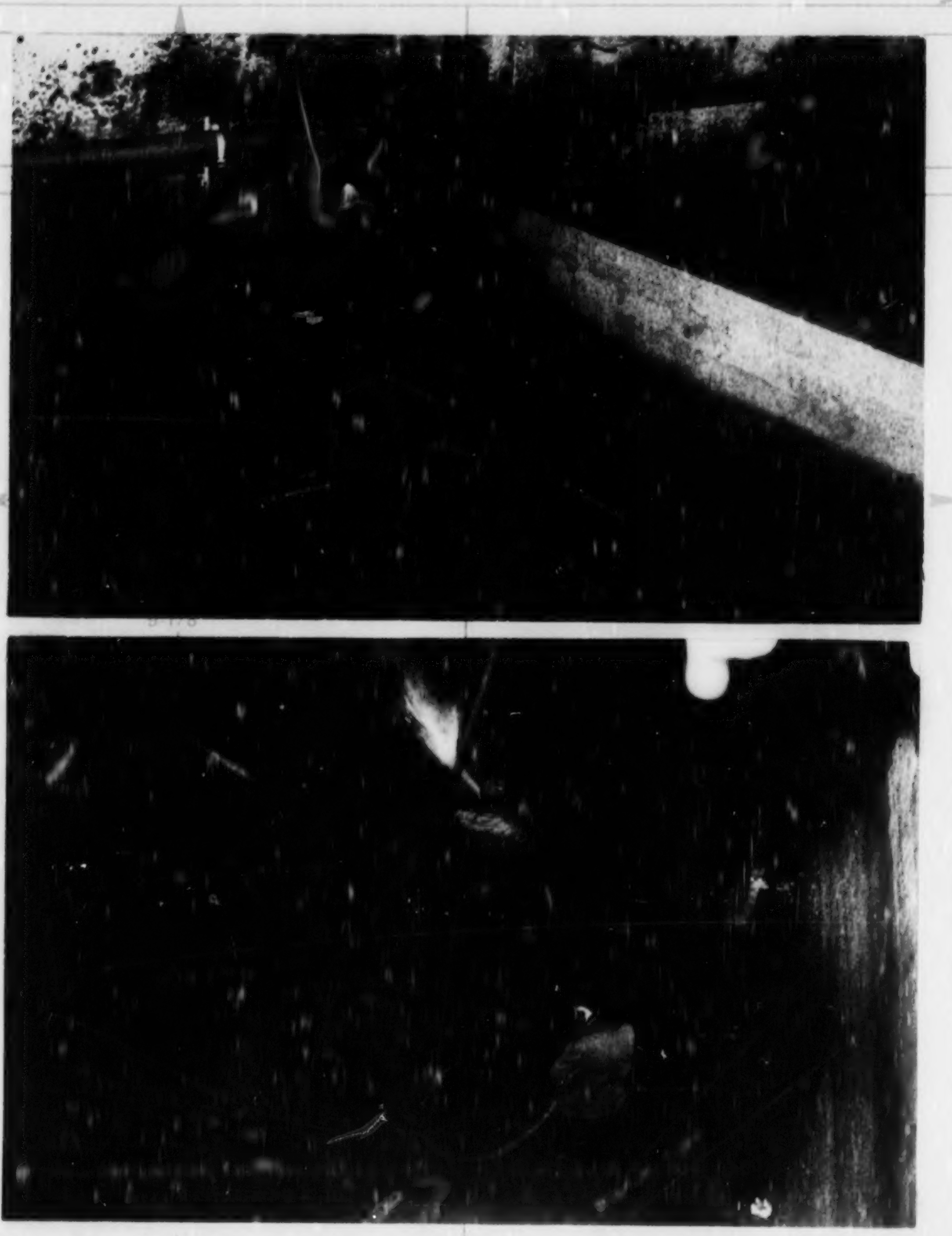

Figure 15. Cleaning Operations. Automatic sprinkler (top); Washing down with fire hose (bottom).

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SECTION V

OPERATING RESULTS

The Cottage Farm Detention and Chlorination Station was placed in operation on April 29, 1971. This report covers the first 38 months of operation, from May, 1971 through June, 1974. Operational, rainfall, and water quality sampling data for this period are included as Appendices A, B and C, respectively.

FREQUENCY, VOLUME AND DURATION OF FLOWS DIVERTED TO THE COTTAGE FARM STATION

It was estimated during the preliminary design that the Cottage Farm Station would be activated 22 times per year. During the period covered by this report, the Station has activated 114 times, or an average of 36 times per year. This is in part due to the abnormally high rainfall in 1972, when one-half of the activations covered by this report occurred.

On the average, 0.09 inches (0.23 cm) of rainfall over a period of 4.8 hours caused flows in the relief sewers to increase sufficiently to be diverted to the Cottage Farm Station. The average maximum intensity of rainfall prior to activation was 0.19 inches per hour (0.48 cm/hr). In general, the station activated within an hour after the maximum preactivation intensity was reached. The average total rainfall and the average duration of storms which activated the Cottage Farm Station were 0.84 inches (2.13 cm) and 10.4 hours, respectively. More complete rainfall data is included as Appendix B, including the design estimates of rainfall intensities sufficient to cause diversions from the North and South Charles Relief Sewers to the Cottage Farm Station.

The design study estimated that 95 percent of the station activations would range from 1 to 13 hours, with a median of 4 hours. The median estimate has been quite accurate (actual median 4.1 hours), though the duration of station activations has been somewhat longer than expected. Durations have ranged from 30 minutes to 43 hours, with 14 percent of the activations lasting longer than 13 hours.

Rainfall data for storms which activated the station are included as Table 5. Actual operating results are compared with estimates made during the design study in Table 6.

The total flow into the facility is determined by adding an estimate of the volume remaining in the wet well and the volume pumped by the stripping pumps to the volumes pumped by the three diesel pumps and the electric pump (as measured by the Dall meters.) In practice, a value of 100,000 gallons has been used in place of the estimates since the main pumps always pump the wet well down to elevation 78.0 before shutting off and the amount pumped through the sluiceway is usually quite small. An estimate of the volume remaining in the detention tanks at the end of the activation (1.2 million gallons when full) was subtracted from the volume pumped to determine the volume which overflowed to the Charles River.

It was estimated during the design study that flows to the Cottage Farm Station would range from 0.4 to 80 million gallons per activation, with an average of 6.3 million gallons. During the 38 months covered by this report, total flows to the facility have ranged from 0.16 to 71.3 million gallons. The average has been 6.7 million gallons per activation.

It is difficult to make meaningful comments about the operation of the Cottage Farm Station from the general averages and ranges of values in the above discussion. An examination of the yearly averages given in Tables 4, 5 and 6 indicates that the above statistics are

Table 4. ANNUAL RAINFALL DATA - BOSTON *

Year	Total Rainfall (inches)	Days with Precipitation greater than 0.01 inches	0.15 in./hr.	0.20 in./hr	Thunderstorm Days
1971	35.67	119	23	20	16
1972	53.11	154	36	26	20
1973	42.75	125	35	25	17
1974	40.34	132	32	23	23
historical mean	41.47	128	--	--	19

* Data from National Weather Service, Boston Logan Airport Station

Table 5. RAINFALL DATA FOR STORMS WHICH ACTIVATED THE COTTAGE FARM STATION
(Average per Activation)

Year	Number of Activations	Rainfall Prior to Activation (inches)	Duration of Rain Prior to Activation (hours)	Intensity Prior to Activation (in /hr.) Average	Maximum Over One Hour Recording Period	Total Rainfall (inches)	Total Duration of Rainfall (hours)	Hours Station Activation Continued After end of Rainfall
1971	18	0.46	3.50	0.13	0.23	0.74	8.4	1.2
1972	57	0.37	4.68	0.06	0.13	0.81	10.4	-2.1
1973	29	0.52	5.75	0.09	0.27	0.98	12.5	2.1
1974	10	0.76	5.65	0.14	0.34	0.82	8.9	0.6
all events	114	0.48	4.80	0.09	0.19	0.86	10.4	-0.2

dominated by data from calendar year 1972, when exactly half of the 114 activations occurred. However, operation during 1973 and the first six months of 1974 - "average" rainfall years - was very close to the projections made during the design study for frequency of activations, rainfall necessary to activate the station, average volume per activation, and duration of activations.

Because the Cottage Farm Station is an element of a dynamic and constantly changing sewerage system, the operation of the Ward Street Headworks and the Deer Island Treatment Plant influence both the frequency and volume of diversions to the Cottage Farm Station. (See Figure 3). The Ward Street Headworks must limit the flows to the Boston Main Drainage Tunnel when the Deer Island Plant's pumping capacity is reduced. When the headworks throttles the inlet gates to control flows passing to Deer Island, the sewers leading to the headworks back up. Thus the Cottage Farm Station will be activated by smaller storms and will receive greater volumes of combined wastewater when the headworks throttles the gates than it would under normal conditions when all the flow reaching the headworks can be passed on to the Deer Island Plant. This was especially true during 1972 and, together with the abnormally high rainfall, accounts for the very high number of activations. This also accounts for the low rainfall intensities prior to activation (Table 5).

Some of the sewers tributary to the Cottage Farm Station are not yet constructed or modified, as outlined in the Metropolitan District Commission's comprehensive plan to abate pollution in the Charles River Basin. The South Charles Relief Sewer was completed five years before work on the Cottage Farm Station was begun. One section of the North Charles Relief Sewer (1,700 ft.) was completed in late 1970, another (4,055 ft.) was completed in 1974, and construction of the final section (4,850 ft.) has not yet begun. The relief sewer to Main Street, Cambridge (5,900 ft.) is now under construction. In addition, the City of Cambridge, is in the midst of a five-year partial sewer separation program designed in part to reduce storm water flows to the North Charles Relief Sewer to the degree necessary to eliminate overflows to the Charles River except for storms greater than once-in-five-year frequency.

The highly combined nature of the North Charles Relief Sewer System at present (Table 1) and the fact that staged construction required separate siphons under the Charles River downstream of the Cottage Farm facility for the North and South Charles Relief Sewers (Figure 6) has also increased the number of diversions to the Cottage Farm Station. Most activations of the station begin with flow diverted from the North Charles Relief Sewer (because it is more influenced by stormwater runoff), even though there may still be capacity in the South Charles Relief Sewer downstream of the Cottage Farm Station. The excess capacity in the South Charles Relief Sewer is not available to flows from the North Charles system however because of the separate siphons under the river. The collection systems and regulators were designed so that, when completed, the North and South Charles systems would both exceed the capacity of their river crossing sections at the same time. This situation will be more closely approached in the future as the Cambridge sewer separation program is completed.

In summary, the frequency, volume and duration of diversions to the Cottage Farm Station match the projections made during the design study when rainfall and other characteristics of the system are taken into consideration. There have, however, been more short, low volume, entirely contained diversions to the station than expected, although this will change when the remaining sections of the North Charles Relief Sewer are completed.

Expected operating results are compared with the actual operation of the Cottage Farm Station in Table 6.

SAMPLING OF FLOWS DIVERTED TO THE COTTAGE FARM STATION

Automatic samplers were installed to sample influent flows just after the fine screens and to sample effluent flows at the outlet end of one of the detention tanks. Both sampling systems consisted of level-activated sampling pumps which maintained constant-head reservoirs from which the automatic samples were taken. The samplers could take from 1 to 100 milliliters of sample at time intervals ranging from one minute to one week. A maximum of twenty-four samples could be taken before the tray of sample vials had to be removed and replaced, and the sampler reset manually.

The sampling system has developed numerous problems ranging from clogged sampling pumps to inaccurate sample volumes taken by the automatic samplers. The necessary remedial modifications were not completed until the summer of 1972. Even when the sampling system was operational, the 100 ml samples provided only enough volume for one or two tests. A complete analysis would require approximately one to two liters of sample.

Table 6. COMPARISON OF EXPECTED TO ACTUAL OPERATING RESULTS

Parameter	Expected	1971 (5 mos)	1972	1973	1974 (6 mos)	Weighted Average
Sodium Hypochlorite: Activations using 300 gal. or less	80%	66%	36%	62%	79%	60%
Contact time: Activations with 30 minutes or more	80%	100%	69%	83%	80%	85%
No discharge to Charles River: Number of Activations entirely contained by the Station	15%	39%	23%	22%	40%	29%
Hours Station activated per year	100	98*	474	133	87*	198
Average duration of activation (hr)	4.6	3.6	8.3	4.9	4.3	5.3
Activations per year	22	27*	57	28	20*	33
Average volume per activation (mg into station)	6.3	2.8	10.3	6.8	4.8	6.7
Duration: Number of activations greater than 4 hours	50%	33%	63%	44%	40%	52%
Duration: Number of activations greater than 13 hours or less than 1 hour	5%	11%	23%	7%	10%	16%
BOD Removal	15%	--	30%	--	74%	48%
Suspended Solids Removal	25%	79%	31%	--	66%	45%

* projected to 12 months

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Because of the difficulties with the sampling systems it was necessary to depend on grab samples for complete analyses of the influent and effluent quality. When the station activated, MDC laboratory personnel were called in to collect samples. However, the majority of plant activations occurred in the evening or early morning when it was difficult to have laboratory personnel at the plant immediately. Therefore, the number of samples taken was limited.

Most samples cover only the first three or four hours of plant activation. Due to manpower limitations, no samples were taken during the final hours to activations which lasted longer than six hours. Samples were transported ten miles to the MDC laboratory and analyzed for Biochemical Oxygen Demand (BOD$_5$), total coliform bacteria, fecal coliform bacteria, chlorides, total solids, total and volatile suspended solids, settleable solids, turbidity, and 15-minute chlorine demand. Residual chlorine analyses were done at the station.

Despite the inclusion of a somewhat elaborate system for automatic sampling, its frequent breakdown and extensive "debugging" period, together with sample size inadequate for the required tests, demonstrate a design deficiency resulting from inadequate emphasis on performance evaluation, and inadequate attention given to this data gathering which is the essence of a demonstration project. This information, which will be used for preliminary evaluation and, it is hoped, design of numerous other projects in many places, is more important to the demonstration than are immediate environmental benefits. An alternative approach to sampling and analysis of plant flows which should be more effective is contained in the Recommendations section of this report.

Characteristics of the activations which were sampled and of all activations which discharged to the Charles River are given in Table 7.

INFLUENT QUALITY

Because the solids which have been deposited during low flow periods are resuspended during periods of higher flow, concentrations of the chemical and bacteriological pollutants in combined wastewater increase significantly at the beginning of high flow periods. Concentrations of many pollutants are also high in urban storm runoff alone. The period of high pollutant concentrations at the beginning of combined wastewater flows is known as the "first flush". After the first flush, the combined wastewater often grows less polluted as dilution by stormwater outweighs the pollution from resuspension of deposited materials.

Recognizing the charactertistics of combined sewer system, the North and South Charles Relief Sewers downstream of the Cottage Farm Station were designed to carry up to 2.1 times the estimated 1985 dry weather flow. It was estimated that flows in excess of this amount, though containing significant quantities of pollutants, would be sufficiently dilute that it

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Table 7. COMPARISON OF SAMPLED ACTIVATIONS TO ALL ACTIVATIONS WHICH DISCHARGED TO THE CHARLES RIVER

	Sampled Activations*	All Activations Which Discharged
Number	18	79
Total Discharge to Charles River (MG)	271.09	764.78
Average Discharge to Charles River (MG)	15.1	9.7
Average Length of Activation (hrs)	13.7	7.9
Average Surface Loading Rate (gal/ft^2/d)	1956	2011
Peak Surface Loading Rate (gal/ft^2/d)	6001	4858
Average Detention Time	75	129
Average Antecedent Dry Days	2.7	1.8
Average Rainfall (in)	1.29	0.89

*All sampled activations discharged to the river would not be economical to transport them to the Deer Island Plant for treatment. Flows in excess of 2.1 times the estimated 1985 dry weather flow (i.e. flows in excess of 185 cfs) are diverted to the Cottage Farm Station for treatment before discharging to the Charles River. Thus, the first 100 cfs of additional flow due to stormwater is carried directly to the Deer Island Plant and never reaches the Cottage Farm Station. Also, most of the solids transported through bed-load movement are carried to the Deer Island Plant as the Cottage Farm Station receives only those flows which overtop the control weirs in the North and South Charles Relief Sewer regulators.

The quality of flows diverted to the Cottage Farm Station is summarized in Table 8. Approximate dry weather flow values are included for comparison purposes. Evidence of resuspension of solids can be noted for small events which did not generate enough flow to cause an overflow to the Charles River. The influent from storms large enough to cause overflows to the Charles River from the Cottage Farm Station was significantly less concentrated during later hours of activation than during the first two hours.

Influent quality bears little correlation with the intensity of rainfall prior to activation or with the dry days elapsed between rain events as demonstrated by Figures 16 and 17. Variations of influent suspended solids and BOD concentrations with time after the initiation of activation are illustrated in Figures 18 to 23.

Table 8 SUMMARY OF INFLUENT QUALITY OF FLOWS DIVERTED TO THE COTTAGE FARM STATION*

	Events which were entirely contained in the detention tanks	Events Which Caused Discharges to the Charles River Samples Taken: During first two hours of plant activation	After the first two hours plant activation	Overall	Dry Weather Flow Quality**
Samples Taken	21	24	17	41	4
Fecal Coliform $\times 10^3$/100 ml	150.8	70.3	24	48.6	320
Total Coliform $\times 10^3$/100 ml	3247	2153	1486	1872	1600
BOD (mg/l)	202	104	80	93	--
Cl^- (mg/l)	182	179	80	129	124
Total Solids (mg/l)	677	558	337	484	528
Suspended Solids (mg/l)	292	196	123	165	103
Volatile Suspended Solids (mg/l)	196	128	58	98	78
Settleable Solids (ml/l)	6.7	5.6	1.8	4.1	--
Turbidity (JTU)	223	140	88	114	--
Chlorine Demand (15 min)(mg/l)	6.6	2.5	2.5	2.5	2.3

* May 1971 - December 1972, Event of 6/4/72 not included

** Average values from two stations near Cottage Farm Bridge, February, 1971

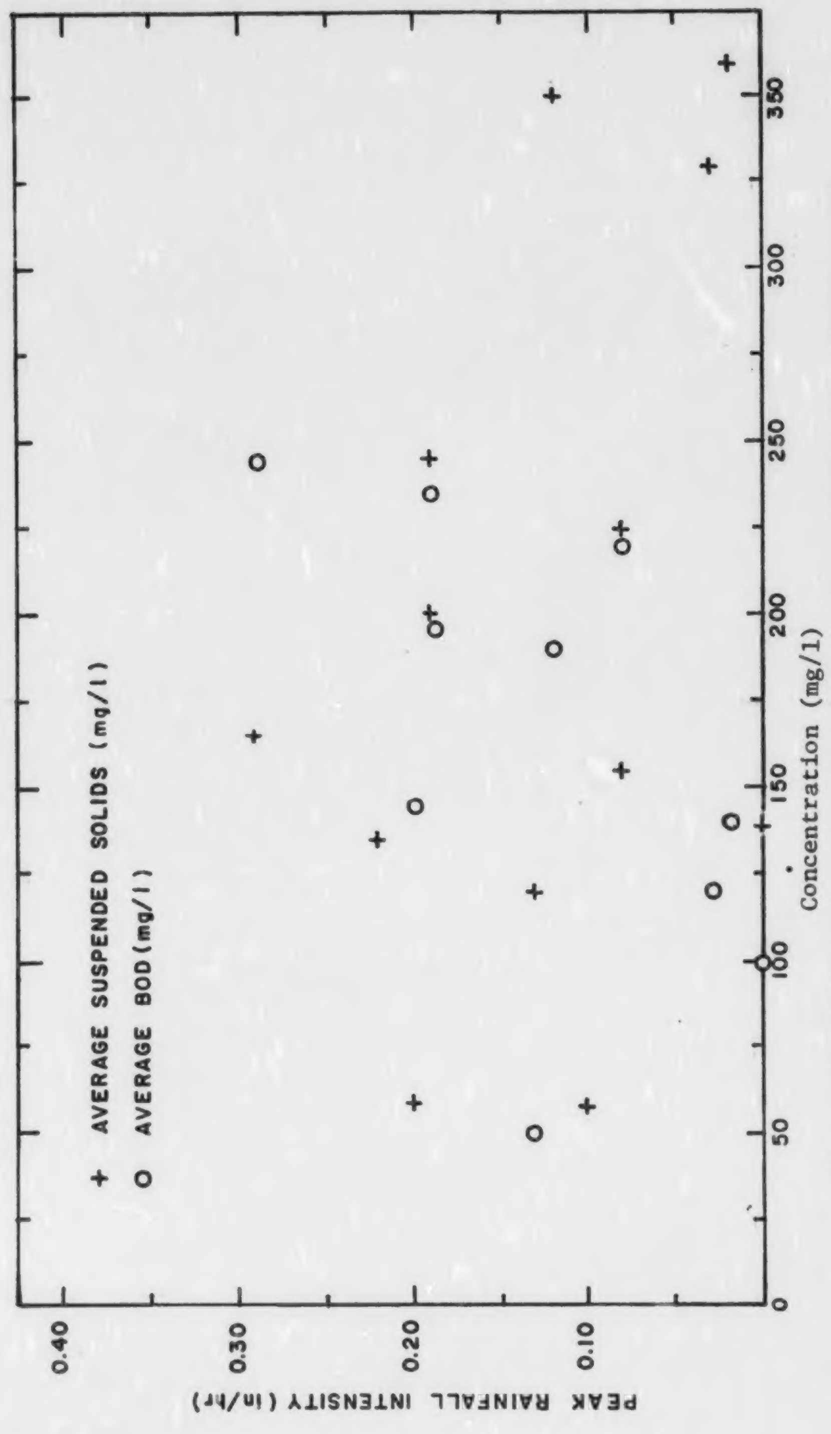

Figure 16. AVERAGE CONCENTRATION DURING FIRST TWO HOURS AFTER ACTIVATION VS, PEAK RAINFALL INTENSITY PRIOR TO ACTIVATION.

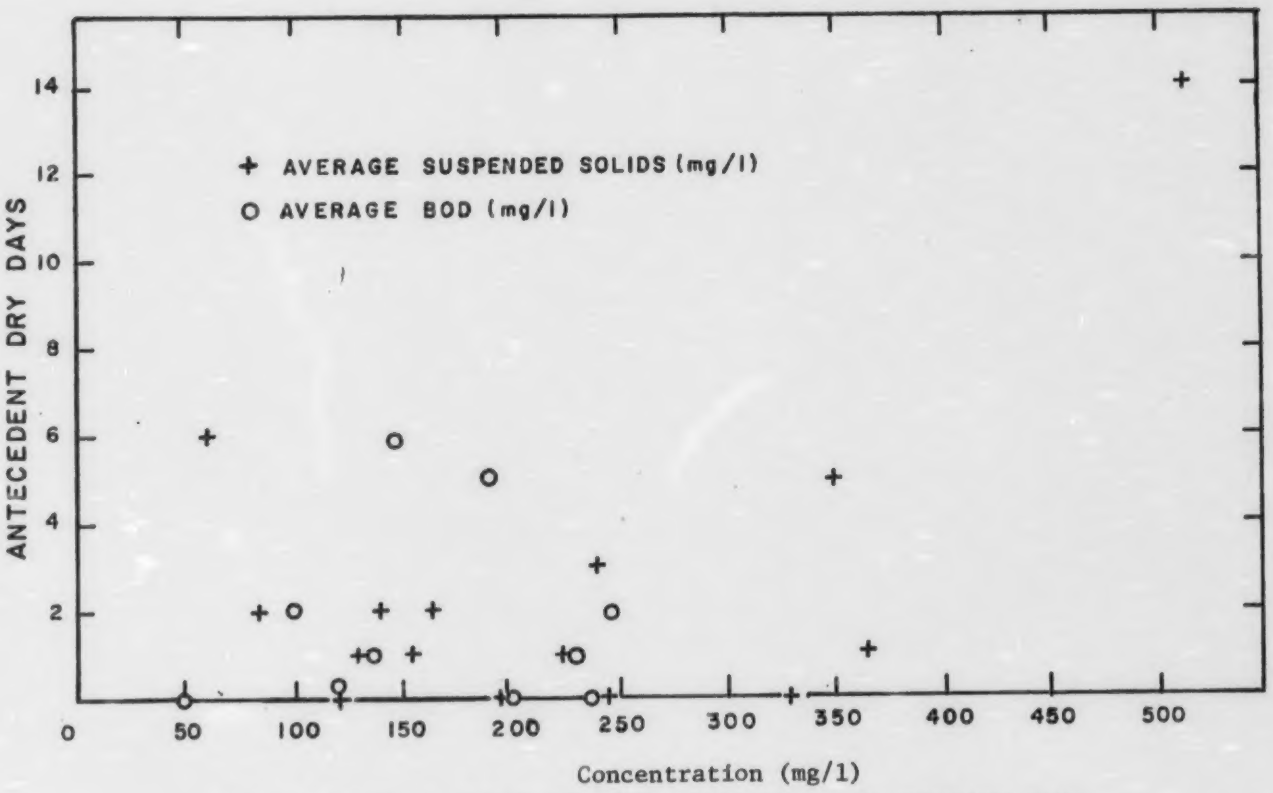

Figure 17. VARIATION OF INFLUENT QUALITY DURING THE FIRST TWO HOURS AFTER ACTIVATION VS. ANTECEDENT DRY DAYS.

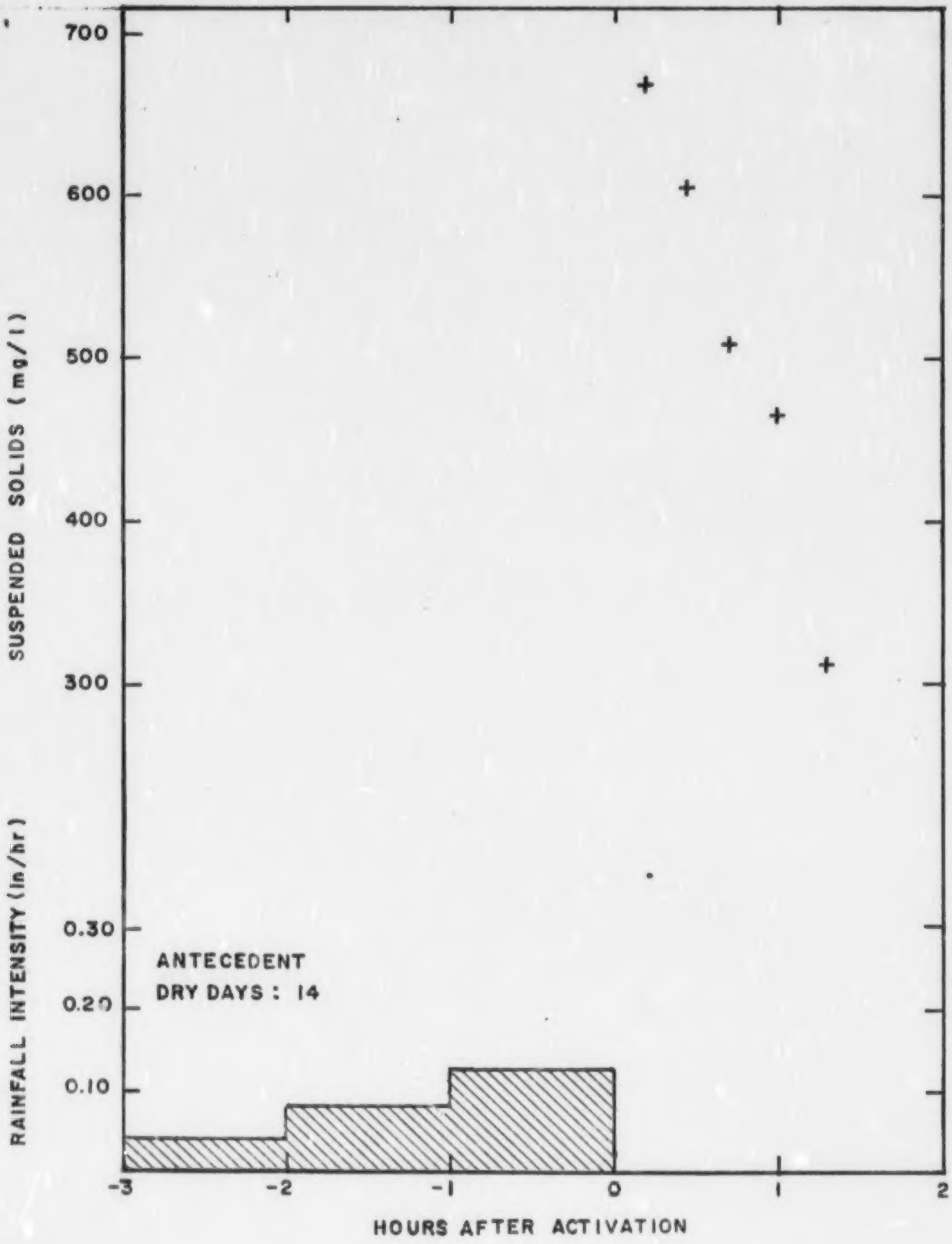

Figure 18. INFLUENT SUSPENDED SOLIDS
10/6/71

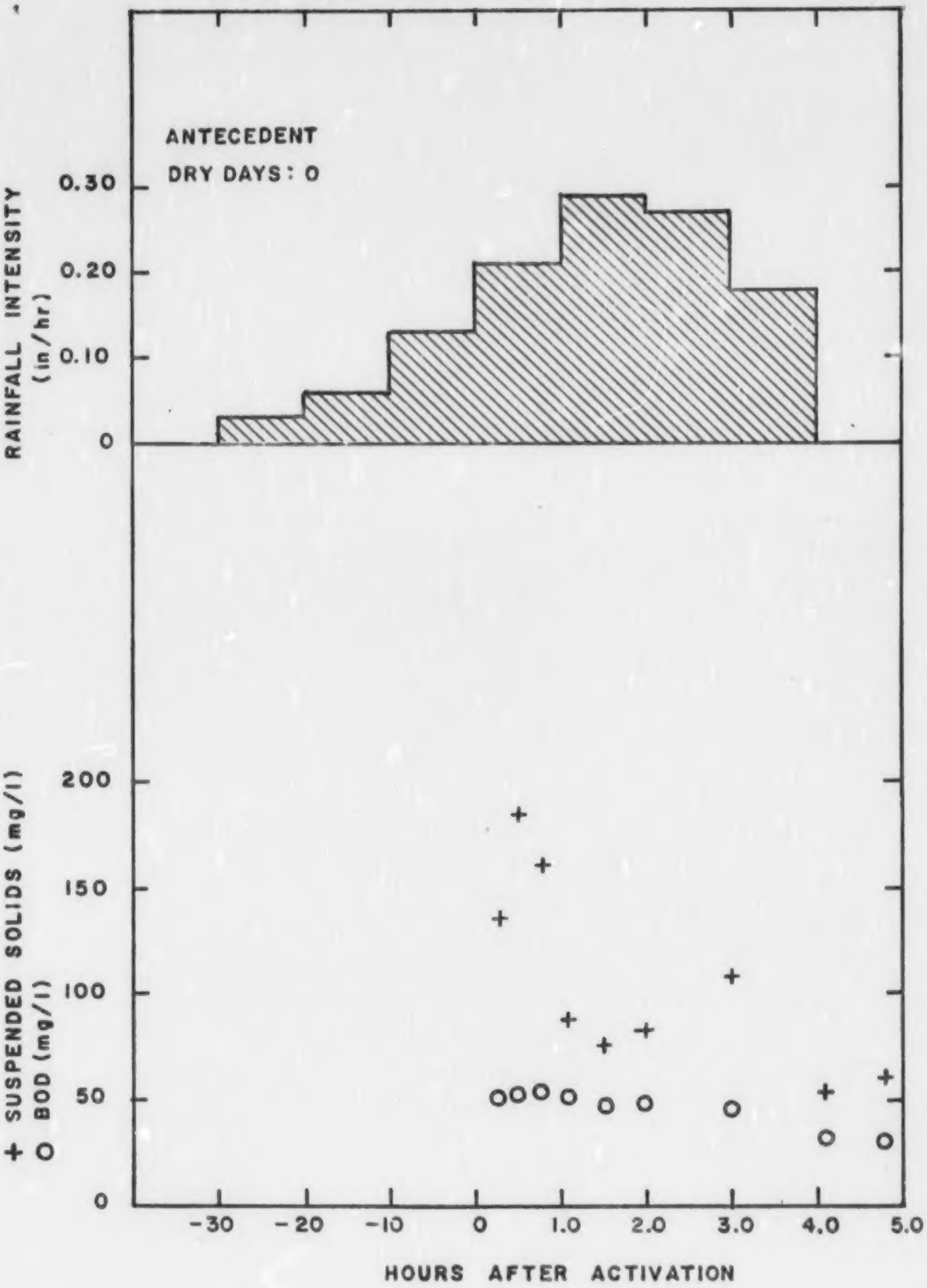

Figure 19. INFLUENT SUSPENDED SOLIDS AND BOD 11/29/71

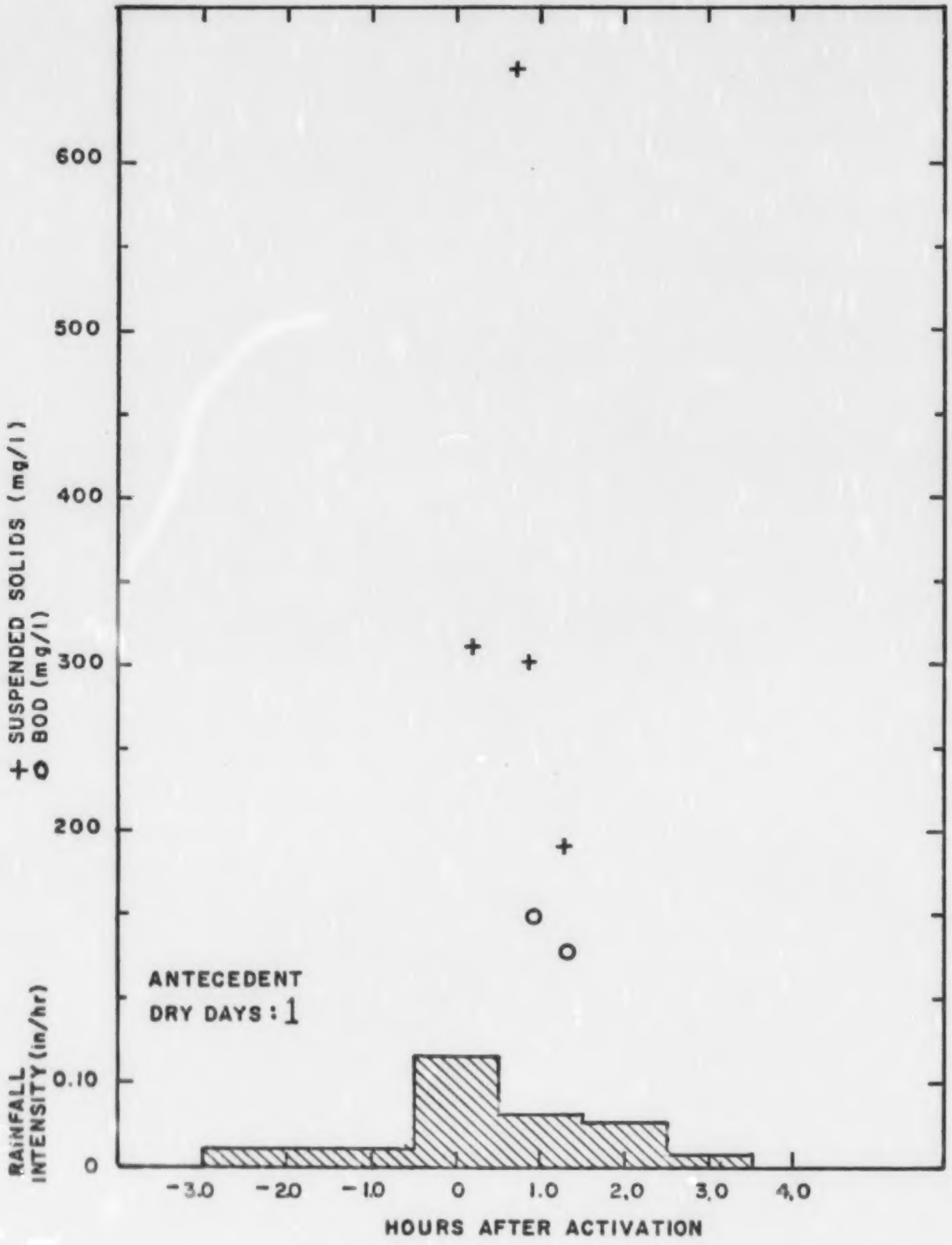

Figure 20. INFLUENT SUSPENDED SOLIDS AND BOD
1/2/72

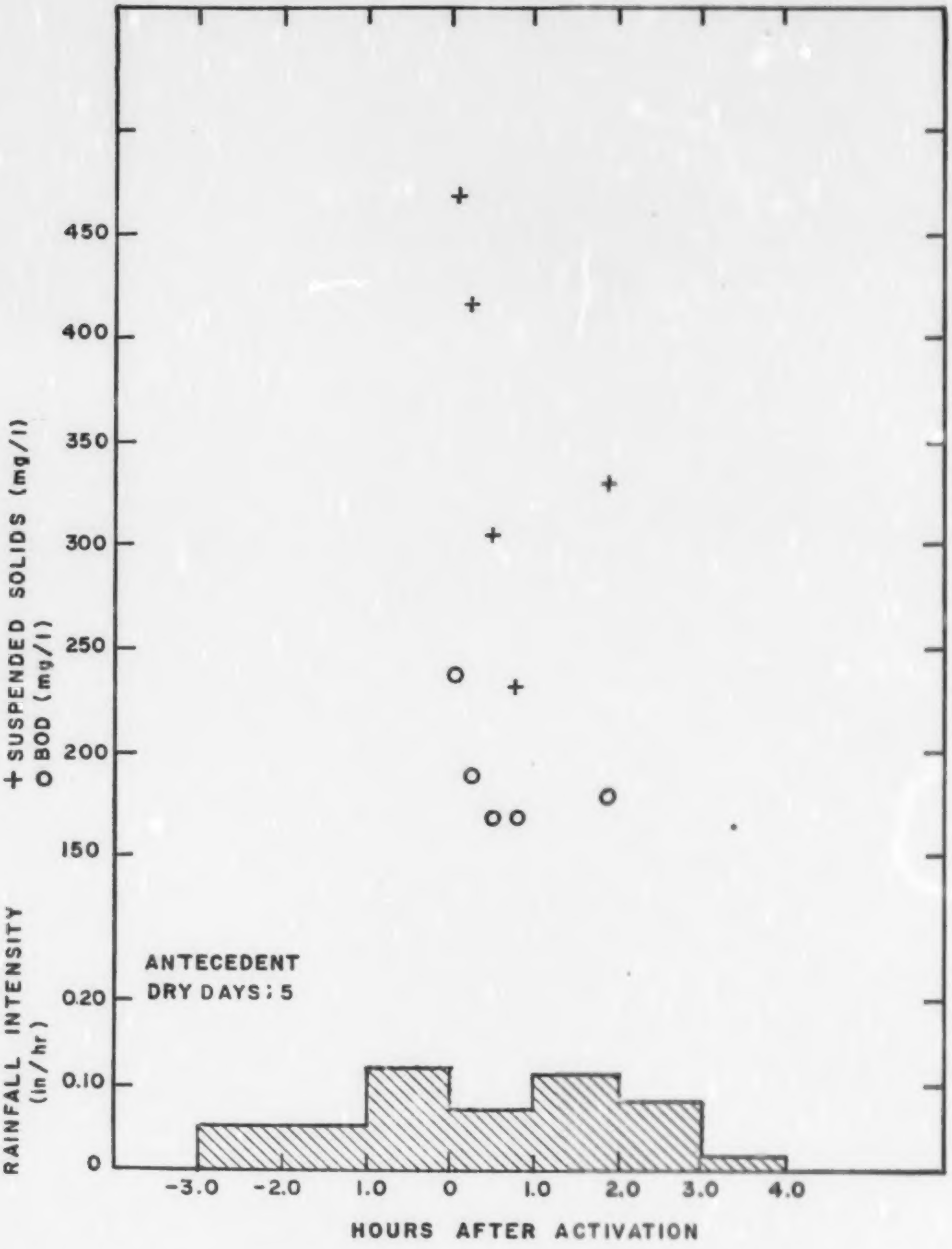

Figure 21. INFLUENT SUSPENDED SOLIDS AND BOD
2/13/72

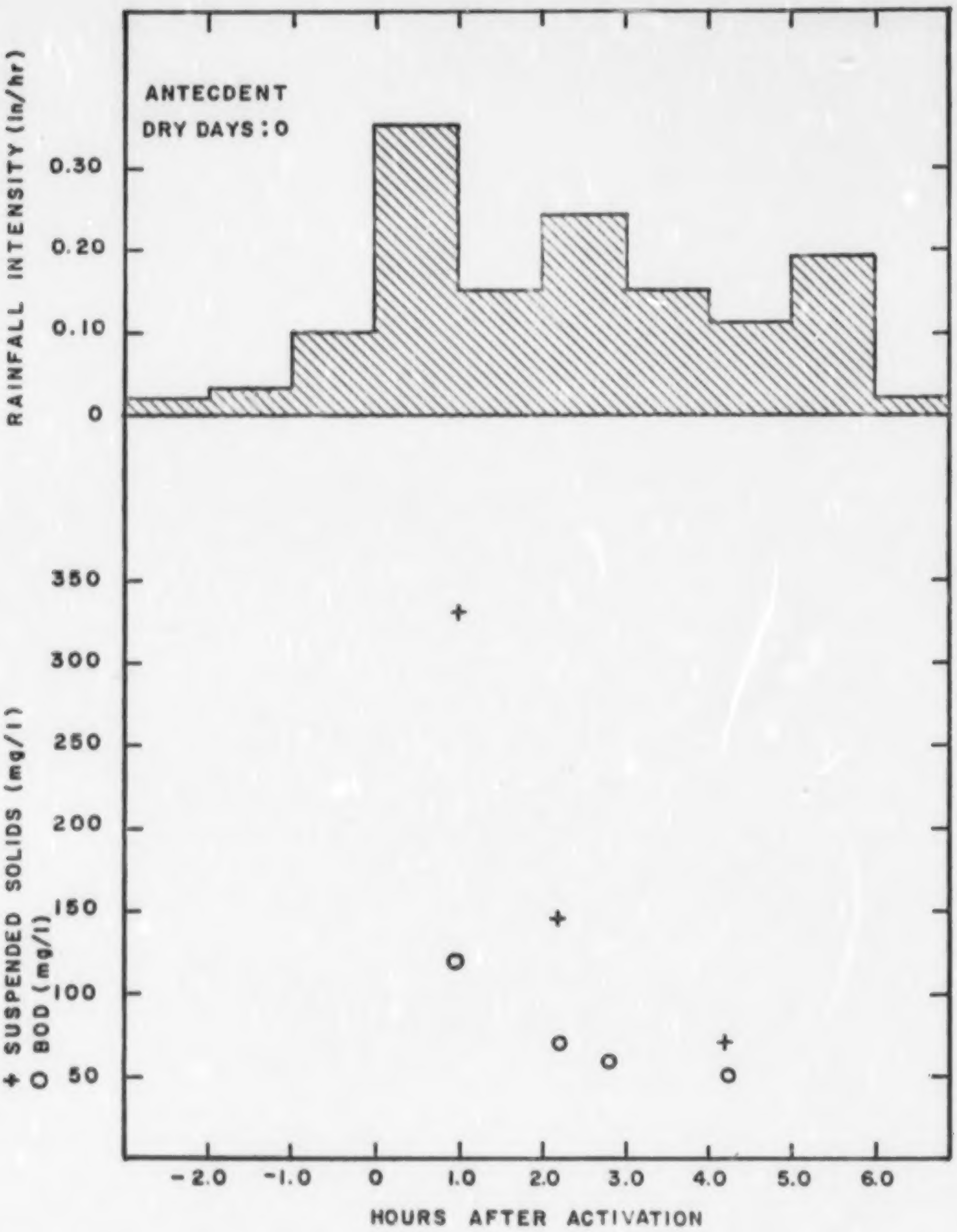

Figure 22. INFLUENT SUSPENDED SOLIDS AND BOD
3/3/72

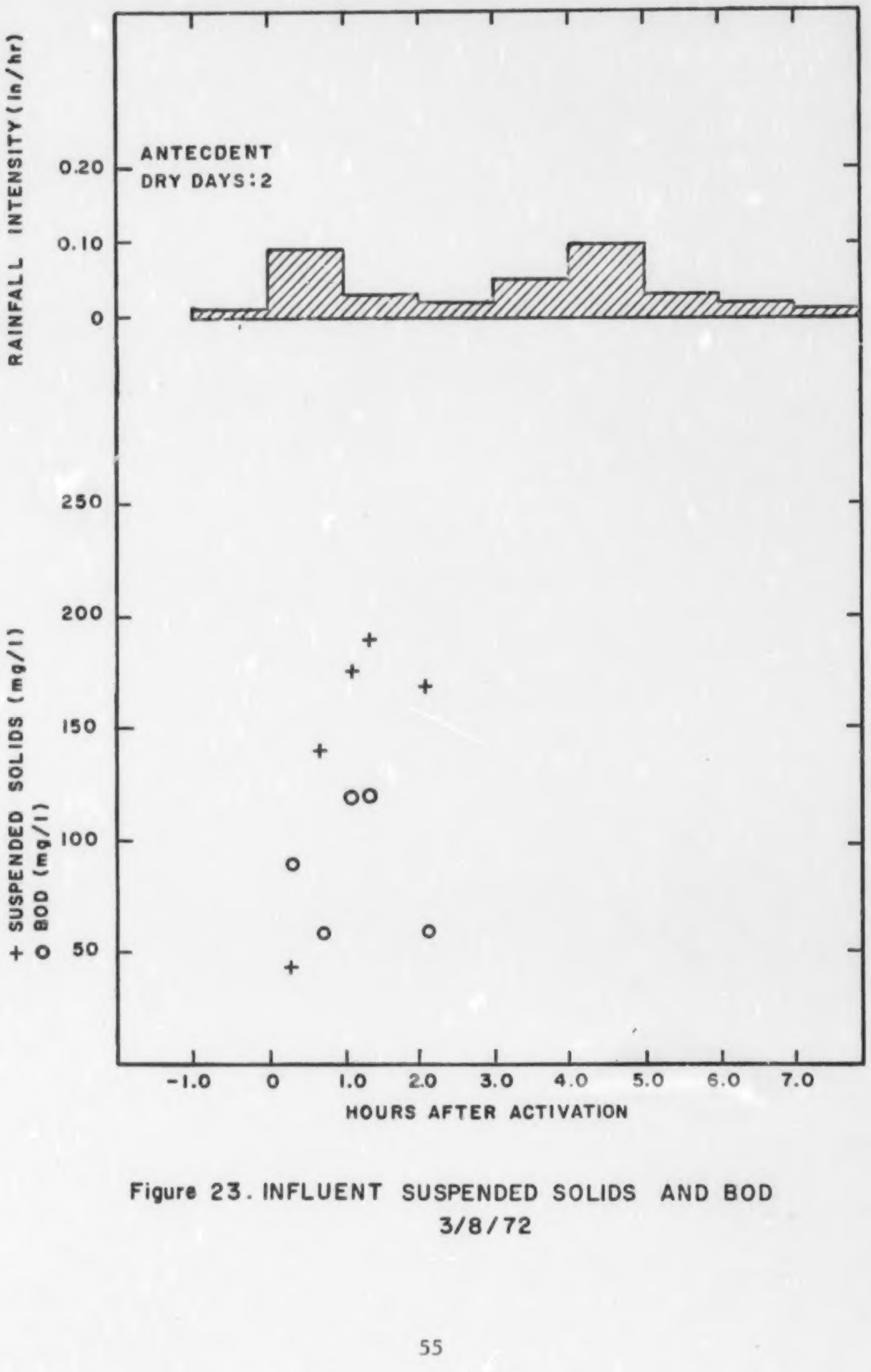

Figure 23. INFLUENT SUSPENDED SOLIDS AND BOD
3/8/72

EFFLUENT QUALITY

Flows diverted to the Cottage Farm Station exceeded the available storage for 79 (69 percent) of the 114 activations covered by this report. The pollutional impact of discharged flows was much reduced by the screening, chlorination, settling and storage provided by the facility.

The reduction of enteric bacteria discharged to the river was one of the primary treatment objectives of the Cottage Farm Station. Unfortunately, during parts of 1971 and 1972, whenever a chlorine residual was found in the effluent, a 99.9 percent kill of coliform bacteria was assumed and no tests were run. Additionally, problems with the chlorination system (discussed later in this report) also hindered achievement of this objective. However, more recent test results, especially data from 1974, demonstrate that high bacterial reductions can be achieved by this facility.

Another major treatment objective was the removal of solids. Significant reductions of both settleable and suspended solids have been achieved by the Cottage Farm Station. Because solids removal tends to be greatest when concentrations are greatest, and concentrations are greatest at the beginnings of activations, and because most of the samples (59 percent) were taken in the first two hours after activation, the removals listed in Table 9 are probably on the high side. On the other hand, the effluent sampling pumps are located ahead of the fine mesh screens and so do not include the removals achieved by them.

Removals from the flows which discharge to the river are only part of the performance of the Cottage Farm facility. Thirty-one (31) percent of all activations of the Cottage Farm Station were entirely contained within the wet well and detention tanks and did not discharge to the Charles River. In addition, approximately 1.3 million gallons from each of the 79 activations which did discharge to the river remained in the detention tanks and wet well when the activation ended. Altogether 115.69 million gallons, or 14 percent of all the flows diverted to the Cottage Farm Station were contained and returned to the sewer system for treatment at the Deer Island Treatment Plant. (See Table 10)

The quantities of pollutants removed via these contained flows is significant as demonstrated by the following example:

Six activations were sampled in 1971, two of which were entirely contained. Of the 22.94 MG diverted to the station in these six

Table 5. AVERAGE PERCENT REMOVAL FOR ACTIVATIONS FOR WHICH WATER OVERFLOWED TO THE [illegible] RIVER

	1971		1972		1973	1974		5/71 -- 6/74	
	Activations Sampled	Average % Removal*	Activations Sampled	Average % Removal*	Activations Sampled	Activations Sampled	Average % Removal*	Activations Sampled	Average % Removal*
Total Number of Activations which Overflowed to River	8		46		--	6		79	
Total Effluent Volume Sampled	16.82		227.97		--	26.40		271.09	
Average Surface Loading Rate of Sampled Activations (gal/sq ft/day)	1784		1817		--	2443		1909	
Fecal Coliform	0	--	1	43	0	2	100	3	81
99.5% removal exceeded	3	--	11	--	--	0	--	16	--
Total Coliform	0	--	5	83	0	3	99.6	8	88
99.5% removal exceeded	3	--	7	--	--	0	--	10	--
Biochemical Oxygen Demand (BOD)	0	--	11	16	0	3	33	14	18
Chlorides	0	--	12	6	0	0	--	15	6
Total Solids	3	63	11	17	0	0	--	15	23
Suspended Solids	3	22	18	37	0	3	63	18	61
Volatile Suspended Solids	3	46	12	20	0	3	48	18	46
Settleable Solids	0	--	11	63	0	3	85	15	67
Turbidity	0	--	10	13	0	0	--	10	13

* activations with "negative" removals assumed to be zero percent removal for these calculations

Table 10. FLOW DIVERTED TO THE COTTAGE FARM STATION WHICH NEVER DISCHARGED TO THE CHARLES RIVER BUT WAS CONTAINED BY THE FACILITY AND RETURNED TO THE SEWER SYSTEM

Year	Events Which Were Entirely Contained		Events Which Discharged To The Charles River		Total Volume Contained (MG)
	Number	Total Volume Contained (MG)	Number	Volume Contained in Detention Tanks and Wet Well (MG)	
1971*	10	6.25	8	9.2	15.45
1972**	13	7.56	44	54.49	62.05
1973	5	1.77	21	26.1	27.87
1974***	4	2.52	6	7.8	10.32
	32	18.10	79	97.59	115.69

* May-December
** No information for 3 events
*** January - June

activations, a total of 6.21 MG were contained and returned to the sewer system. The concentrations of suspended solids and the percent removals computed from the samples taken for the six activations are listed in columns 5 and 6 of Table 11. From these and the flow data of columns 2 and 3, the pounds of suspended solids which entered the station and the pounds which were removed from flows which discharged to the river were computed. The pounds of suspended solids in the volumes which were contained in the Cottage Farm Station were computed using columns 4 and 5. In all, then, 25,912 of the 42,282 pounds which entered the facility (fully 64 percent) were "removed" by the facility and prevented from entering the river. Using the totals of columns 2,3,4, and 7,8,9 mass per unit volume rates can be computed. These can be used to extrapolate the results of the sampled activations to all the activations of 1971.

Thus it is concluded that 79 percent (75,164 pounds of 95,379 pounds) of the suspended solids entering the plant between May and December 1971, was prevented from reaching the Charles River and returned to the sewer system.

(The percent captured over the entire year is greater than that for the six activations sampled because of the higher percentage of flows which did not discharge to the river in the former).

Records of other calculations similar to the above example are included in Appendix C and summarized in Tables 12 and 13.

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Table 11. SUSPENDED SOLIDS REMOVAL - 1971

Date	Influent Volume (MG)	Effluent Volume (MG)	Stored Volume (MG)	Influent Conc. (mg/l)	% Removal	Pounds Influent	Pounds Removed From Effluent	Pounds Stored	Total Pounds Removed	Overall % Removal
5/13	5.20	3.90	1.30	542.0	77.0	23694.	13568.	5874.	19441.	83.
5/16	7.20	5.90	1.30	96.0	1.0	5842.	46.	1018.	1065.	19.
6/8	3.27	1.97	1.30	240.0	22.0	6542.	867.	2601.	3468.	53.
7/1	0.82	0.0	0.82	0.0	100.0	0.	0.	0.	0.	0.
10/6	0.29	0.0	0.29	611.0	100.0	1243.	0.	1243.	1243.	100.
11/29	6.16	4.86	1.30	105.0	0.0	5392.	0.	1138.	1138.	71.
TOTAL	22.94	16.63	6.31			42312.	14481.	11873.	26355.	
AVG/MG SAMPLED				229.5	29.7	1913.	1230.	2163.		
TOTAL FOR YEAR	49.92	34.47	15.46			95400.	42410.	33414.	75824.	79.

Table 12. SUMMARY OF TREATMENT EFFICIENCY

	1971 (8 mos)	1972	1973	1974 (6 mos)	'71 - '74 Avg. Per Activation	'71 - '74 Total
mg into station	49.92	586.49	177.62	68.44		880.47
mg discharged to river	36.47	522.64	140.76	58.12		764.78
Avg.Surface loading rate(gal/ft^2/day)	1,479	1,940	2,336	2,103	1,965	
No.of activations	18	57	29	10		114
No. of activities sampled	6	15	0	4		25
mg of activations sampled	22.94	244.65	0	31.48		299.08
SUSPENDED SOLIDS						
Avg. Inf. Conc. (mg/l)	229.5	110.6	-	247.7	152	
Est. Total lbs into station	95,490	538,996	-	141,204		775,690
Est. total lbs removed from discharged flow	42,410	85,725	-	74,048		202,183
Est. total lbs contained	33,414	80,773	-	19,614		133,801
Est. overall % removal	79	31	-	66	45	
Est. % removal from discharged flow	30	13	-	61	22	
VOLATILE SUSPENDED SOLIDS						
Avg. Inf. Conc. (mg/l)	114.5	55.9	-	117.8	76	
Est. Total lbs into station	47,630	272,225	-	67,235		387,090
Est. Total lbs removed from discharged flow	15,923	88,547	-	37,878		142,348
Est. Total lbs contained	17,894	49,738	-	10,645		78,277
Est. overall % removal	71	51	-	72	58	
Est. % removal from discharged flow	30	32	-	66	37	
SETTLEABLE SOLIDS						
Avg. Inf. Conc. (ml/l	-	1.7	-	3.7	2.0	
Est. Total ft^3 into station	-	135,637	-	33,831		169,468
Est. Total ft^3 removed from discharged flow	-	56,154	-	24,604		80,758
Est. Total ft^3 contained	-	35,254	-	3,472		38,726
Est. overall % removal	-	66	-	83	69	
Est. % removal from discharged flow	-	54	-	83	58	
B.O.D.						
Avg. Inf. Conc (mg/l)	-	99.6	-	72.7	96	
Est. Total lbs into station	-	485,196	-	41,466		526,662
Est Total lbs removed from discharged flow	-	95,459	-	24,538		119,997
Est. Total lbs contained	-	80,427	-	6,172		86,599
Est. Overall % removal	-	36	-	74	42	
Est. % removal from discharged flow	-	17	-	66	24	

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Table 13. PERFORMANCE BY UNIT VOLUME (POUNDS OR CUBIC FEET PER MILLION GALLONS)

	1971 (8 mos.)	1972	1973	1974 (6 mos.)	Weighted Average by Volume in
mg into station	49.92	584.49	177.62	68.44	
mg discharged to river	36.47	522.44	149.75	58.12	
avg surface loading rate(gal/ft^2/day)	1479	1940	2334	2163	2010
No. of activations	18	57	29	10	
No. of activations sampled	6	15	0	4	
mg of flow sampled	22.94	244.65	0	31.49	
SUSPENDED SOLIDS					
lbs SS/mg into station	1913	922	-	2064	1104
lbs SS/mg contained	2163	1302	-	1901	1421
lbs SS removed/mg discharged to river	1230	164	-	1274	348
overall % removal	79	31	-	66	38
VOLATILE SUSPENDED SOLIDS					
lbs VSS/mg into station	954	466	-	962	551
lbs VSS/mg contained	1145	802	-	1031	869
lbs VSS removed/mg discharged to river	462	169	-	652	237
overall % removal	71	51	-	72	64
SETTLEABLE SOLIDS					
ft^{3}solids/mg into station	-	232	-	494	288
ft^{3}solids/mg contained	-	568	-	336	564
ft^{3}solids removed/mg discharged to river	-	104	-	423	137
overall % removal	-	66	-	83	68
B.O.D.					
lbs BOD/mg into station	-	830	-	686	597
lbs BOD/mg contained	-	1296	-	909	1223
lbs BOD removed/mg discharged into river	-	183	-	422	308
overall % removal	-	36	-	74	40

EFFECT OF THE COTTAGE FARM STATION ON WATER QUALITY IN THE LOWER CHARLES RIVER

Although the Charles is narrow and well mixed near the Cottage Farm Station, it quickly widens to form a broad, two-mile-long basin. The Lower Basin, as it is called, receives combined sewer overflows from the Cities of Cambridge and Boston, and is permanently stratified by the large volume of saline water trapped behind the Old Charles River Dam.

Considering the size of the Lower Basin, the poor quality of the water entering the basin from upstream, the already poor water quality due to its stratified nature, and the continuing pollution from other combined sewer overflows, no noticeable improvement in Charles River water quality can be expected from the operation of the Cottage Farm facility alone. Significant improvement in water quality in the Lower Charles River Basin will be achieved only by the elimination of a significant amount of the pollution sources.

In fact, as can be seen in Table 14, changes in water quality are not yet differentiable from the variability inherent in the samples themselves. Water quality data from a sampling station 6 miles upstream of the Cottage Farm Station has been included in Table 14 to indicate that the pollution of the Lower Basin due to upstream sources is significant. The improvement in water quality due to the Cottage Farm Station in comparison with the variability of ambient Charles River water quality can be seen in Table 15.

The major benefits of the Cottage Farm Station are not in terms of the reduction of suspended solids or BOD concentrations in the river, although considerable amounts of these substances were removed (See Table 16), but in terms of the removal of floatables and pathogenic bacteria from the discharged flows.

The most important uses of the Charles River Lower Basin at present and in the near future are as an aesthetic amenity and for passive, non contact recreation on the river and along the river banks. To protect and enhance these uses, improvements in the visual quality of the river and virtual elimination of potential for transmission of water-borne diseases are required. The records of the Cottage Farm Station demonstrate that it has been highly effective in removing floatables and coliform bacteria from the excess combined sewage transmitted to it via the North and South Charles Relief Sewers.

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Table 14. WATER QUALITY IN THE CHARLES RIVER

Year	Number of Samples	Total Coliform #/100 ml	Fecal Coliform #/100 ml	BOD mg/1	Suspended Solids (mg/1)	Volatile Suspended Solids (mg/1)
SAMPLES AT COTTAGE FARM BRIDGE - RIVER MILE 3.7)						
1968	11	66,127	--	4.7	--	--
1969	12	37,486	--	3.8	--	--
1970	13	7,448	--	3.2	11	5
1971	16	31,669	281	4.6	19	8
1972	3	7,367	700	3.4	8	5
1973	16	5,464*	192*	5.3	12	7
1974	16	2,400*	--	9.0	16	--
AVERAGE VALUES IN LOWER BASIN (SAMPLING STATIONS AT RIVER MILES 1.2, 2.6, 3.7)						
1968	31	35,694	--	4.0	--	--
1969	34	27,151	--	3.0	--	--
1970	36	7,378	--	3.2	10	5
1971	49	18,469	1017	4.3	14	8
1972	9	13,524	1056	3.6	6	4
1973	47	6,479*	125*	5.2	10	6
1974	46	2,800*	--	8.0	14	--
SAMPLES AT WATERTOWN DAM (RIVER MILE 9.8)						
1968	12	9,888	--	3.7	--	--
1969	12	24,975	--	3.8	--	--
1970	13	15,892	--	4.0	11	6
1971	17	4,633	328	3.9	13	7
1972	3	6,333	667	3.6	10	5
1973	17	886*	180*	5.0	17	7
1974	17	1,500*	--	5.0	14	--

* Geometric Average

Table 15. CALCULATED DECREASE IN SUSPENDED SOLIDS CONCENTRATIONS DUE TO THE COTTAGE FARM STATION

Year	Average Discharge at Cottage Farm Bridge (mgd)	Suspended Solids Removed per Activation (lb)	Equivalent mg/l Removed On Days Station Activated*	Average Suspended Solids in Charles River at Cottage Farm Bridge (mg/l)	Range of Charles River Suspended Solids (mg/l) min.--max.	Percent Improvement Due to Station On Days Station Activated
1971	261	4212	1.92	11	4 -- 38	15
1972	406	2921	0.86	19	6 -- 32	4
1973	420	--	--	8	7 -- 15	--
1974	357	9296	3.10	12	5 -- 25	21

* equivalent mg/l = SS removed per activation/Average Discharge

Table 15. part two

Year	Average Discharge at Cottage Farm Bridge (mgd)	Average Suspended Solids in Charles River at Cottage Farm Bridge (mg/l)	Total Annual Suspended Solids in Charles River (lbs)	Total Annual Suspended Solids Removed by Cottage Farm (lbs)	Percent Improvement in Mass of Suspended Solids in River Due to Removals By Cottage Farm Station
1971	261	11	8,737,860	42,410	0.5
1972	406	19	23,430,360	85,723	0.4
1973	420	8	10,214,480	--	--
1974	357	12	13,023,360	74,368	0.6

Table 16. ESTIMATED MASSES OF POLLUTANTS REMOVED BY THE COTTAGE FARM STATION
(pounds unless stated otherwise)

Parameter	1971*	1972	1973	1974**	5/71 to 6/74	Overall Percent Removal
BOD	--	175,887	--	30,709	206,596	39
Suspended Solids	75,824	166,498	--	93,662	335,984	43
Volatile Suspended Solids	33,616	138,285	--	48,523	220,424	57
Settleable Solids (ft^3)	--	89,408	--	28,076	117,484	69

* 8 months
** 6 months

SECTION VI

PERFORMANCE OF THE COTTAGE FARM STATION

SCREENING

Most of the screenings occurred at the beginning of overflows to the Cottage Farm Station. The screenings tapered off to essentially nothing as the flow continued.

The volume of fine screenings removed cannot be measured easily since the fine screenings are continually flushed back to the sewer by the stripping pumps. Instead, screenings were estimated by assuming that a volume of 1 in. x 1 in. x 8.67 ft. (the length of the rake) was dumped into the sluiceway by each rake each revolution during the first 25 minutes of plant activation and that screenings after the first 25 minutes were negligible. By this method, it is estimated that 17 cubic feet (0.48 cubic meters) of screenings are removed per activation. Over the 38 months covered by this report, an estimated 1,948 cubic feet (55.2 cubic meters) of fine screenings were removed and returned to the sewer system downstream of the Cottage Farm Station via the 18-inch sluiceway. The fine screens worked effectively, with perhaps five percent of the screenings dropping back into the flow.

The coarse screenings removals were minimal. They were estimated from amounts in the dumpcarts at one cubic foot per activation. The coarse screens could be eliminated at the Cottage Farm Station except that large objects must be removed separately from the fine screenings so that they do not jam in the 18-inch sluiceway. There were so few coarse screenings that they were all deposited in dumpcarts for subsequent disposal rather than sorted manually as had been suggested in the original design.

Mesh screens with 0.2-inch clear openings were provided ahead of the effluent weirs for final screening before the chlorinated overflow discharged to the Charles River. Each section of the fine mesh screens is hinged to allow it to swing open if it becomes clogged. This has happen during only a half dozen storms, and then only several sections of the screens on only two or three tanks were forced open. The material adhering to the screens is easily washed off during the post-activation clean-up operation. An estimated five cubic feet of the material was retained on the fine mesh screens per activation. (Figure 24)

CHLORINATION

During the 90 activations for which data was recorded, 48,012 gallons of sodium hypochlorite were used, an average of 533 gallons per activation. On a unit basis 57 gallons of sodium hypochlorite, purchased strength 15 percent, were needed per million gallons of combined wastewater diverted to the station. Thirteen storms in 1972 were treated in whole or in part with sodium hypochlorite generated on-site by an automatic system developed by Ionics, Inc. for the Environmental Protection Agency (Project No. 11023 DAA). The description and evaluation of this system is available in their report to the EPA dated March, 1973.

Several problems with the chlorination system arose during the initial operation of the Cottage Farm Station. These problmes will be briefly identified below. Further comments are included in the Recommendations.

The main difficulty was maintaining residual chlorine at of 1 ppm in the detention tank effluent. Several factors probably contributed to the highly variable residual chlorine:

1. The residual chlorine analyzer is located too far from the sampling pump which in turn is too far from the dosage point.

2. The hypochlorite feeder was unable to respond adequately to highly concentrated flows when the hypochlorite strength was low (due to long storage before use) or to low chlorine demand flows when the hypochlorite solution was strong (i.e. just after delivery).

3. The hypochlorite feeders occasionally had to be run manually because of malfunction of the residual chlorine analyzer or malfunction of the flow transmitter (due to clogged pressure lines from pumps to the flow meters). At such times, best results were obtained by running the pump(s) manually as well.

At the Cottage Farm Station, electronic chlorination equipment is in the same room with the sodium hypochlorite feeders, and just around the corner from the sodium hypochlorite storage tanks. It has suffered significant corrosion as a result. All storage tanks and feeders should be in a room by themselves. A drain should be provided from the sodium hypochlorite storage areas to either the wet well or the detention tanks in case of spillage.

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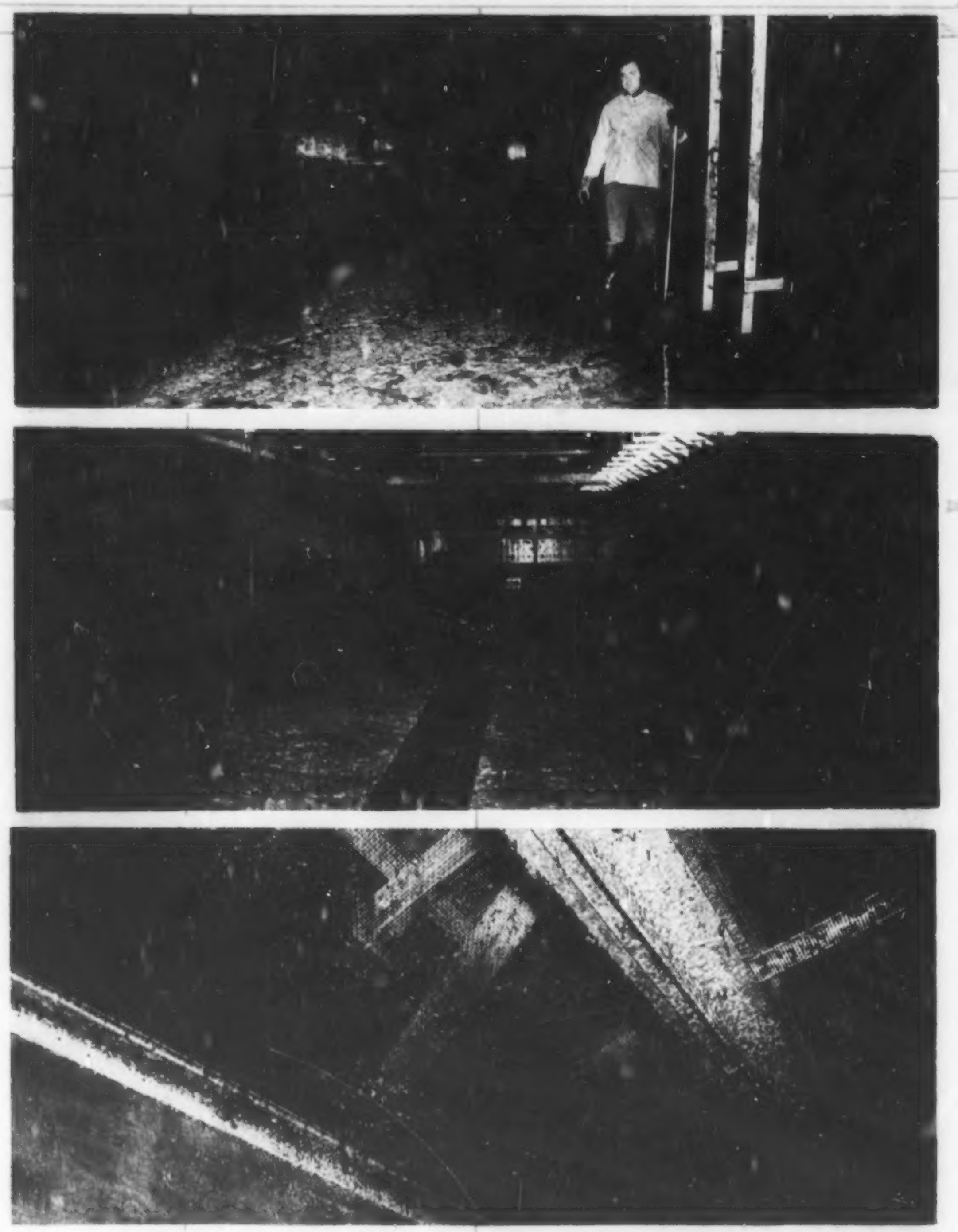

Figure 24. Sludge Accumulations. Wet well (top); Detention tank (center); Fine mesh screens (bottom).

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Table 17 VARIATION IN AVERAGE EFFLUENT CHLORINE RESIDUALS (AT END OF RETENTION TANKS - ELAPSED TIME VARIES)

Activation Number	1972		1973		1974	
	Number of Samples	Average Chlorine Residual (mg/ℓ)	Number of Samples	Average Chlorine Residual (mg/ℓ)	Number of Samples	Average Chlorine Residual (mg/ℓ)
3	2	4.2	6	1.5	6	0.6
4		-		-	2	1.16
5		-		-	2	0.5
6		-	4	3.6		-
7	4	4.3		-		-
8	3	2.0	12	3.7	2	1.7
9		-	3	1.1		
10	7	1.88		-		
11	5	1.05		-		
16	4	0.52	4	0.8		
19		-	2	0.25		
20	9	1.90	4	0.88		
21	7	4.63	4	0.28		
22	8	2.56		-		
23	14	2.56		-		
24		-	2	1.86		
25	24	2.29		-		
26	4	0.81	3	1.06		
28		-	9	0.98		
31	3	1.42				
32	8	0.74				
34	4	0.41				
35	5	2.90				
36	6	3.39				
37	3	4.88				
40	11	0.46				
42	3	1.86				
43	2	0.56				
46	3	1.25				
48	22	2.44				
49	8	1.79				
50	5	2.58				
54	5	2.8				
55	16	1.99				

PUMPING EQUIPMENT

As described earlier, the one electric and three diesel pumps are set to start up automatically at predetermined wet well elevations. Fifteen percent of the overflows to the station were entirely contained in the wet well and did not activate any of the main pumps. These were pumped out by the stripping pumps.

The electrically driven pump was set to start first to provide flexible, automatic operation at low overflow rates. The operation of the electrically driven pump was easily adjusted and very reliable. Fully 25 percent of the activations which activated the main pumps were handled by the electrically driven pump alone.

Although the problems with the diesel pumps have been relatively minor, their solution was complicated by the fact that the station could not be activated artificially. It was necessary to wait for the next storm to check the adjustments to the automatic controls. An intermittently operating facility, such as a chlorination and detention station, should have provisions for overflow simulation for checkout, so that equipment may be adjusted and tested at any time.

The Cottage Farm Station has experienced persistent problems with the flow recording system. Because of the importance of accurate flow measurements to the evaluation of the station's performance, it is recommended that all flow meters be calibrated routinely and that duplicate means of measuring and recording flows be provided in all future facilities of this nature.

WATER SYSTEM

Two wells located adjacent to the river are used for cooling water and for washing down the facility at the end of activations. The use of non-potable water for these purposes has been satisfactory. The quantity available has not always been adequate for cooling all diesel pump motors at the same time. The supply of potable City of Cambridge water alone is also inadequate. Use of both constitutes across connection and requires special precautions to protect the City of Cambridge water supply.

VENTILATION SYSTEM

The original ventilation system provided fresh air ventilation in the screen and detention tank areas only. Additional ventilation has since been added to the wet well area to preclude gas accumulation there and to the pump discharge channel to dissipate chlorine odors. Exhaust air is filtered through activated carbon cannisters before discharging to the atmosphere. No odors have ever been detected emanating from the facility.

TEL-EYE PROBES

The Cottage Farm Station uses four tel-eye probes. One probe is located in the inlet structure and opens the 72-inch inlet sluice gates. Two probes are used in the wet well to start and stop the stripping pumps and the coarse and fine screens, and to open the inlet sluice gates if the probe in the inlet structure fails. The fourth probe is located in the pump discharge channel to start the chlorine residual sampling pump. The tel-eye probes work well where the velocity is high enough to keep them clean. In the wet well, sediment adhered to the surface of the probes and maintained contact when the probes were above the water level. The two probes in the wet well have been replaced with pressure sensors.

SUMMARY OF OPERATION DATA

Table 18 contains a summary of operational data from the Cottage Farm Station during the period 1971 to 1974.

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Table 10. SUMMARY OF OPERATIONAL DATA

	1971 (6 mos.)	1972	1973	1974 (6 mos.)	7/1/71 to 6/30/74	Average
Number of times station activated	18	57	29	10	114	
Number of times flows discharged to the Charles River Basin	8	44	21	6	79	
Total flow diverted into the station (mg)	49.92	584.49	177.62	68.44	880.47	
Total flow contained and returned to the sewer system (mg)	15.45	62.05	27.87	10.32	115.69	
Total flow discharged to the Charles River Basin (mg)	34.47	522.44	149.75	58.12	764.78	
Average flow diverted into the station per activation (mg)	2.77	10.25	6.83	6.84		6.67
Smallest flow diverted into the station (mg)	0.16	0.10	0.10	0.30		0.21
Largest flow diverted into the station (mg)	10.06	71.3	38.4	32.5		38.3
Total hours of station activation (hrs)	66.5	473.5	133.2	43.3	715.5	
Average duration of station activation (hrs)	3.6	8.3	4.9	4.3		5.3
Median duration of station activation(statistical median)(hrs)	2.3	5.0	4.0	3.6		3.7
Longest duration of station activation (hrs)	18.5	43.1	21.7	12.0		24.0
Average rainfall during storms which activated station (in)	0.74	0.81	0.98	0.82		0.84
Average intensity prior to station activation(in/hr)	0.13	0.06	0.09	0.14		0.11
Average maximum intensity prior to station activation (in/hr)	0.23	0.13	0.27	0.24		0.22
Average duration of storms which activated the station (hrs)	8.4	10.4	12.5	8.9		10.1
Number of times station activation ended before storm ended	11	16	12	6	45	
Average pumping rate (mgd)	16	25	33	25		25
Number of times the electric pump activated	13	46	16	9	84	
Number of times one or more diesel pumps activated	8	35	18	4	65	
Average surface loading rate (gal/sq ft/day)	1479	1980	2334	2183		2011
Total amount of sodium hypochlorite used (gal)	2673	32840	9199	3300	48012	
Amount of sodium hypochlorite generated on-site (gal)	0	12975	0	0	12975	
Average amount of NaOCl used per storm (gal)	446	576	368	330	533	
Maximum amount of NaOCl used per storm (gal)	1420	3400	1000	900		
Average detention time provided for flows which discharged to the river (min)	77	135	65	190		117
Coliform bacteria kill in flows which discharged to the river	100%	97.9%	--	99.9%		99.2%
Suspended Solids removed: - overall	75%	31%	--	68%		46%
- from flows which discharged to the river	30%	13%	--	61%		22%
Volatile Suspended Solids removed: - overall	71%	51%	--	72%		58%
- from flows which discharged to the river	38%	32%	--	66%		37%
B.O.D. removed: - overall	--	38%	--	74%		42%
- from flows which discharged to the river	--	17%	---	66%		24%
Settleable Solids removed: - overall	--	60%	--	83%		69%
- from flows which discharged to the river	--	54%	--	83%		58%
Fine screenings removed per activation (est) (cu ft)	--	--	--	--		17.00
Coarse screenings removed per activation (est) cu ft)	--	--	--	--		1.0

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SECTION VII

CONSTRUCTION AND OPERATIONAL COSTS

CONSTRUCTION COSTS

The total construction cost of the Cottage Farm Detention and Chlorination System was $4,851,961. The Federal Water Quality Administration (now the U.S. Environmental Protection Agency) supported this project by a $1,000,000 demonstration grant. A break down of the major equipment and construction items is given in Table 19.

The relief sewer construction associated with the Cottage Farm Station is listed in Table 20. This construction was necessary to collect the excess combined sewage and transport it to the Cottage Farm Bridge site.

OPERATION AND MAINTENANCE COSTS

The actual cost of operating and maintaining the Cottage Farm Station over the thirty-eight months covered by this report does not reflect the true operation and maintainance cost of the facility as it includes costs associated with debugging operations.

An approximate annual cost for chemicals and energy, or cost per unit volume treated, can be calculated, however, based upon historical records since the amounts used are roughly proportional to the volume of wastewater diverted. This data and the resultant cost estimates are given in Table 21. Also, the present personnel costs can be used to estimate costs for an "average" year. These are tabulated in Table 22. The cost of replacing the activated carbon cannisters, not included in the above tables or this discussion, is estimated to be about 3500 dollars (1155 pieces).

The cost to operate and maintain the Cottage Farm Station is approximately $81,500/year, using June 1974 price information. This amounts to a unit cost of 29.3¢/1000 gallons of wastewater diverted to the facility.

Table 19. EQUIPMENT AND CONSTRUCTION COSTS (MAJOR ITEMS)

Item	Cost
Meters and Instrumentation	$ 125,000
Sluice Gates	30,000
Coarse and Fine Screens	150,000
Main Pumps and Controls	430,000
Sampling Equipment	10,000
Chlorination Equipment	90,000
96' Subaqueous Outfall	40,000
Electrical System	160,000
Inside Piping	135,000
Butterfly Valves	63,000
Excavation	145,000
Cofferdam	790,000
Steel Sheeting	207,750
Concrete	655,000
Cement	89,370
Re-Steel	312,000
Other	1,419,841
Total	4,851,961

Table 20. RELIEF SEWER SECTIONS AND COMPLETION DATES

Contract Number	Section	Overflows Connected to the Station	Date Completed	Amount
SOUTH CHARLES RELIEF SEWER				
C-200	Section 1-Cambridge & Boston		11/30/66	$2,448,815.16
C-201	Section 2 - Brighton		4/30/57	1,222,361.86
C-202	Section 3 - Watertown, Newton & Boston		11/6/57	983,447.93
C-203	Section 4 - Watertown, Newton & Boston		6/30/56	888,637.09
C-204	Section 5 - Brighton, Roxbury & Brookline		10/1/60	6,118,930.86
C-222	Section 4A - Waltham		3/1/59	1,079,307.33
		14		
NORTH CHARLES RELIEF SEWER				
C-206	Charles River Sewer Crossing Cambridge, Brighton & Boston	0	6/30/57	1,440,808.22
C-207A	Section 1A - Cambridge	3	8/29/70	1,382,684.31
C-207B	Section 1B - Cambridge	4	9/19/74	4,429,641.86
C-208	Section 2 - Cambridge	6		Pending
C-209	Section 3 - Cambridge	4		3,761,230.00*
		17		

* Basis of Award - Contract still in progress

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Table 21. OPERATING COSTS: ENERGY AND CHEMICALS

	AMOUNT USED			Total Used	Amount Used per MG into Station	6/74 Unit Cost (approx.)	Cost per MG into Station	Cost per Year (at 278 MG/yr and 36 activations/yr)
	FY '72	FY '73	FY '74					
Sodium Hypochlorite 15% (gal.)	14,300	23,763	5,359	43,408	49	$0.34	$16.66	$ 4631
Fuel Oil (gal.)	18,000	19,950	15,174	53,124	60	$0.3415	$20.49	$ 5696
Electric Power (kwh)	258,800	253,000	198,200	710,000	807	$0.078 (Avg)	$62.95	$17,500
Carbon Cannisters	not replaced yet							
Total							$100.10	$27,827

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Table 22. OPERATIONAL COSTS: PERSONNEL & SALARIES[a]

Function	PERSONNEL				Days Per Year	Cost Per Day[b]	Cost Per Year	Cost Per MG In @278 MG in/yr & 36 Activations/yr
	STP Operator	Foreman	Skilled Laborers	Laborers				
Plant Operation	1	0	0	4	365	-	$43,296[c]	$155.74
Post-activation Cleanup	0	1	2	2	36	$161.24	5,805	20.88
Groundskeeping	0	1	2	2	24	161.24	3,870	13.92
Snow Removal	0	0	2	0	10	63.22	632	2.27
Total							$53,603	$192.81

a - not including fringe benefits, etc.

b- 6/74 base salaries:

STP Operator	$12,000/yr
Foreman	37.54/dy
Skilled Laborer	31.61/dy
Laborer	30.24/dy

c- includes overtime

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SECTION VIII

PUBLICATIONS

"Detention and Chlorination Station Solves Combined Sewer Overflow Problems Economically," K. Peter Devenis, C.E. Maguire, Waltham, Mass., Public Works Magazine, November 1971.

"Programs to Improve Water Quality in the Lower Charles River Basin," K. Peter Devenis, C.E. Maguire, Inc., Waltham, Mass., Journal of the New England Water Pollution Control Association, Vol. 7, No. 2, December, 1973. (Presented at the spring 1973 meeting.)

"Combined Sewage Overflow Detention and Chlorination Station near Boston University Bridge," K. Peter Devinis, Journal, New England Water Pollution Control Association, Vol. 2 October, 1968.

"Combating Pollution From Stormwater Overflow" J. Richard Feibelman, BIF Div. General Signal Corp., Providence R.I., Journal Providence Engineering Society, Vol. XLVII #3, October 18, 1971

"Cottage Farm Stormwater Treatment Station" A.L. Fabrizio, W.A. Brutsch, MDC Engineering Division, Journal of the New England Water Pollution Control Association, Vol. 7, No. 2, December, 1973. (Presented at the spring 1973 meeting.)

SECTION IX

GLOSSARY

Anaerobic Digestion- The degradation of organic matter brought about through the action of micro-organisms in the absence of molecular oxygen.

BOD_5-Abbreviation for biochemical oxygen demand. The quantity of oxygen used in the biochemical oxidation of organic matter in a specified time, at a specified temperature, and under specified conditions. Also, a standard test used in assessing wastewater pollution strength.

Chlorination- The application of chlorine to water or wastewater, generally for the purpose of disinfection, but frequently for accomplishing other biological or chemical results.

Combined Sewage - A mixture of sanitary sewage and storm runoff from roof drains, catch basins, etc.

Digester- A tank in which sludge is held for partial biological decomposition of the organic matter, resulting in partial gasification, liquification and mineralization.

Dissolved Oxygen- The oxygen dissolved in water, wastewater, or other liquid usually expressed in milligrams per liter, parts per million, or percent of saturation. Abbreviated DO.

Domestic Wastewater- Wastewater which includes all of the water-borne wastes originating from residential, commercial, and recreational developments and the water-borne wastes originating from the sanitary facilities of industrial development.

Dry Weather Flows- Normal wastewater flow with little or no stormwater or groundwater infiltration.

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Effluent-Water, wastewater, or other liquid, partially or completely treated, flowing out of a reservoir, basin or treatment plant, or any unit thereof.

Excess Combined Sewage-That volume of combined sewage which exceeds the capacity of the sewers and therefore must overflow to a nearby water body or another receiver.

Infiltration-The water entering a sewer system from the ground through such means as defective pipes, pipe joints, connections, or manhole walls. Infiltration does not include inflow.

Inflow-The water discharged into a sewer system from such sources as roof leaders, cellar, yard, and area drains, foundation drains, cooling water discharges, drains from springs and swampy areas, manhole covers, connections from other sewers, catch basins, surface runoff, street wash waters, or drainage. It does not include infiltration.

Infiltration/Inflow-The total quantity of water from both infiltration and inflow without distinguishing the source.

Influent-Water, wastewater, or other liquid flowing into a reservoir, basin or treatment plant, or any unit thereof.

Organic matter-Carboniferous chemical substances, usually of animal or vegetable origin.

Outfall-A conduit leading from a treatment plant or wastewater collection system to the point of final discharge.

pH-The logarithm of the reciprocal of the hydrogen-ion concentration, in moles per liter of solution. Neutral water, for example, has a pH value of 7 and a hydrogen-ion concentration of 10^{-7} moles per liter.

Present Worth-The present worth of a cost occurring at some future point in time is the present amount of money, that when invested at a selected interest rate, will yeild that amount at that future time. Likewise it is the present value, discounted at the applicable interest rate, of an obligation payable at a future time.

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Primary Treatment- The first major (sometimes the only) treatment in a wastewater treatment plant, usually sedimentation. Primary treatment removes a substantial amount of suspended matter but little or no colloidal and dissolved matter.

Secondary Treatment- The treatment of wastewater by biological or physical-chemical methods after primary treatment by sedimentation.

Sedimentation- The process of subsidence and deposition of suspended matter carried by water or wastewater, by gravity. It is usually accomplished by reducing the velocity of wastewater below the point at which it can transport the suspended matters.

Sewage- The spent water of a community. Term now being replaced in technical usage by the more preferable term, wastewater. See Wastewater.

Sludge- The accumulated solids separated from liquids such as water or wastewater, during processing, or the deposits on bottoms of streams or other bodies of water. Also, the precipitate resulting from chemical treatment, coagulation or sedimentation of water or wastewater.

Sludge Digestion- The process by which organic or volatile matter in sludge is gasified, liquified, mineralized, or converted into more stable organic matter through the activities of either anaerobic or aerobic organisms.

Suspended Solids- Solids that either float on the surface or are in suspension in water, wastewater, or other liquids, and which are largely removable by laboratory filtering.

Tertiary Treatment- The treatment of wastewater beyond secondary treatment by using various physical and chemical processes. Tertiary treatment can include processes to remove additional suspended solids, BOD or plant nutrients like nitrogen or phosphorus.

Turbidity- Opalescence in water or wastewater caused by the presence of suspended matter, which results in the scattering of light rays. It is often used as an approximate measure of the concentrations of fine suspended matter in liquids.

Wastewater-The spent water of a community. From the standpoint of source, it may be a combination of the water-carried wastes from residences, commerical buildings, industrial plants, and institutions, together with any ground-water, surface water, and storm water that may be present. In recent years, the word "wastewater" has taken precedence over the word "sewage".

Wastewater Reclamation-Treatment of wastewater for reuse, either for irrigation or agricultural lands or landscape, for ground-water recharge, for stream flow augmentation, for surface impoundments, or for industrial purposes.

Wastewater Treatment-Any process to which wastewater is subjected in order to remove or alter its objectionable constituents and thus render it less offensive or dangerous. See Primary Treatment, Secondary Treatment, Tertiary Treatment.

Wastewater Treatment Plant-An arrangement of devices and structures for treating wastewater, including those for disposition of sludges removed from the wastewater. Sometimes used as synonymous with waste treatment plant, water pollution control plant, or water reclamation plant.

Wet Weather Flow-A combination of dry weather flows and infiltration/inflow which occurs as a result of rainstorms. This flow, in combined sewer systems or in older or poorly constructed sanitary systems, can be many times the dry weather flow.

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SECTION X

ABBREVIATIONS AND SYMBOLS

adwf	average dry weather flow
BOD_5	biochemical oxygen demand (5-day)
cu. ft.	cubic feet
cu. m.	cubic meter
ft.	feet (foot)
gal.	gallon
gad	gallons per acre per day
gpd	gallons per day
gpdsf	gallons per day per square foot
gpcd	gallons per capita per day
gpm	gallons per minute
hp	horsepower
kg	kilogram
l	liter
lbs/day	pounds per day
lps	liter per second
m	meter
MG	million gallons
mgd	million gallons per day
mg/l	milligrams per liter

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pad	pounds per acre per day
pdwf	peak dry weather flow (hourly rate)
ppcd	pounds per capita per day
psi	pounds per square inch
pwwf	peak wet weather flow (hourly rate)
sq. ft.	square feet (foot)
sq. m.	square meter
Set. S.	settleable solids
SS	suspended solids

SECTION XI

METRIC UNITS AND ENGLISH EQUIVALENTS

Recommended Units

Description	Unit	Symbol	English Equivalents
Length	meter	m	3.28 ft.
	centimeter	cm	0.3937 in.
Area	square meter	m^2	10.744 sq. ft.
	square centimeter	cm^2	0.155 sq. in.
	Hectare (10,000 m^2)	ha	2,471 acres
Volume	cubic meter	m^3	35.314 cu. ft.
	liter	l	o.264 gal.
Mass	kilogram	kg	2.205 lb.
Time	second	s	S
Velocity	meter per second	m/s	3.28fps
Flow	cubic meter per second	m^3/s	15,850 gpm or 35.314 cfs
	liter per second	l/s	15.85 gpm
Pressure	kilogram (force) per square centimeter	kgf/cm^2	14.223 psi
Temperature	degree Celsius	C	$C=\frac{5}{9}(F-32)$
Hydraulic Loading	cubic meters per square meter per day	$m^3/m^2/day$	24.58 gpdsf

APPENDIX A

OPERATIONAL DATA

May, 1971 - June, 1974

NOTES

Volume into station = Volume pumped + 0.1 MG

Volume discharged = Volume pumped - 1.2 MG

except when the detention tanks were partially full at the beginning of the activation

Duration of Activation - time from first overflow into the station to the end of pumping or the end of overflow from detention tanks, whichever is greater

Average Pumping Rate = Volume pumped x 24/Duration of Activation

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1971 - OPERATIONAL DATA

Date	Volume Into Station (mg)	Volume Discharged to River (mg)	Duration of Activation (hrs)	NaOCl Com. (gal)	NaOCl Ionic (gal)	Total Rainfall (in)	Average Pumping Rate (mgd)	Surface Loading Rate (gal/ft²/d)	Peak Pumping Rate (mgd)	Pumps Used Elect.	Pumps Used Diesel
5/13	5.2	3.9	3.5	NR	0	0.68	35	2000	NR	1	2
5/16	7.2	5.9	5.1	NR	0	1.10	33	1886	NR	1	1
6/3	1.22	0	1.1	NR	0	0.46	27	-	-	1	1
6/8	3.27	1.97	2.3	NR	0	0.47	33	1886	NR	1	1
6/21	1.23	0	1.3	60	0	0.46	21	-	-	1	0
7/1	0.02	0	2.2	36	0	0.48	8	-	-	1	0
7/17	0.16	0	0.7	NR	0	0.36	2	-	-	0	0
7/19	0.23	0	1.6	NR	0	0.77	2	-	-	0	0
7/30	3.53	2.23	4.1	NR	0	0.82	20	1143	63	1	2
8/20	0.22	0	1.4	NR	0	0.23	2	-	-	0	0
8/27	0.44	0	4.1	NR	0	0.76	2	-	-	0	0
9/9	0.51	0	1.7	NR	0	0.09	6	-	-	1	0
9/13	1.13	0	3.3	282	0	0.92	7	-	-	1	0
10/6	0.29	0	2.3	NR	0	0.24	2	-	-	0	0
10/10	6.24	4.94	4.4	NR	0	1.30	34	1943	140	1	3
11/25	10.84	9.54	16.5	1420	0	2.59	14	800	90	1	3
11/28	1.23	1.13	1.9	300	0	0.58	14	800	25	1	0
11/29	6.16	4.86	6.0	575	0	1.09	24	1372	130	1	2
Total	49.92	34.47	65.5	2673			286	11830			
Avg.	2.77	4.31	3.6	445.5			16	1479			

9-1/8"

1972 - OPERATIONAL DATA _PAGE 1

Date	Volume Into Station (mg)	Volume Discharged to River (mg)	Duration of Activation (hrs)	NaOCl Com. (gal)	NaOCl Ionic (gal)	Total Rainfall (in)	Average Pumping Rate (mgd)	Surface Loading Rate (gal/ft²/d)	Peak Pumping Rate (mgd)	Pumps Used Elect.	Pumps Used Diesel
1/2	1.4	0.1	3.25	100	0	1.07	10	571	25	1	0
1/19	1.6	0.3	3.25	50	0	0	11	-	65	0	3
2/3	18.1	16.8	8.2	750	0	1.19	53	3029	140	1	2
2/13	0.85	0	4.2	0	0	0.90	4	-	-	1	1
2/29	0.18	0	2.0	-	-	0	1	-	-	0	0
3/1	1.0	0	1.6	60	0	0	13	-	-	1	0
3/3	71.3	70.0	23.0	3000	0	1.92	74	4229	140	1	3
3/8	7.3	6.0	14.6	235	0	0.37	12	686	20	1	0
3/16	1.6	0.3	4.5	40	0	Tr	8	-	-	1	1
3/17	19.3	18	30.8	900	0	0.69	15	857	85	1	3
3/22	10.3	9.0	14	825	0	0.50	18	1029	140	1	3
3/24	1.55	0.25	31	50	0	Tr	1	57	25	1	0
4/13	0.9	0	3.8	25	0	0.54	5	-	-	1	0
4/17	0.3	0.01	1.7	0	0	0.13	3	-	-	1	0
4/20	1.1	0	4.3	125	0	0.72	6	-	-	1	0
4/23	5.3	4.0	4.6	125	0	-	27	1543	100	1	2
5/3	22.1	20.8	6.8	535	0	1.40	78	4458	170	1	3
5/9	1.7	0.4	8	0	0	0	5	-	-	-	-
5/9	2.1	0.8	8	50	0	0.68	6	-	-	0	0
5/15	3.86	2.56	4.8	375	0	1.14	19	1086	35	1	1
5/20	3.46	2.16	5.6	400	0	0.63	14	800	30	1	0
5/31	26.6	25.3	16.3	850	0	1.29	39	2229	140	1	3
6/4	16.1	14.8	14.6	1050	50	1.25	26	1486	90	1	1
6/7	0.35	0	3.7	-	-	0.46	2	-	-	0	0
6/9	61.1	59.8	43.1	300	2900	1.46	34	1943	130	1	3
6/17	4.35	3.05	3.2	210	0	0.40	32	1829	80	1	1
6/19	0.36	0.14	1.1	15	0	0.23	5	286	23	1	0
6/22	0.20	0	1.3	-	-	0.36	2	-	-	0	0
6/23	0.7	0	2.3	65	0	0.17	6	-	-	0	1
6/30	2.7	1.4	4.1	20	0	0.49	15	857	90	0	2
7/13	10.3	9.0	3.3	0	925	0.86	74	4229	130	1	3
7/19	8.1	6.8	5.6	0	375	0.11	34	1943	110	1	2
7/21	2.47	1.17	1.0	0	75	0.10	57	3258	110	1	1
7/24	14.1	12.8	3.7	0	1175	1.03	91	5201	180	1	3
7/24	6.1	4.8	4.3	600	0	0.03	34	1943	70	1	1
7/25	6.3	5.0	6.5	680	0	0.10	23	1315	80	1	2

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1972 - OPERATIONAL DATA -PAGE 2

Date	Volume Into Station (mg)	Volume Discharged to River (mg)	Duration of Activation (hrs)	NaOCl (gal) Com.	NaOCl (gal) Ionic	Total Rainfall (in)	Average Pumping Rate (mgd)	Surface Loading Rate (gal/ft²/d)	Peak Pumping Rate (mgd)	Pumps Used Elect.	Pumps Used Diesel
7/26	2.1	0.8	2.8	420	0	0	17	972	75	1	1
8/1	2.0	0.7	2.7	200	0	0.27	17	972	75	1	2
8/8	0.18	0	1.0	-	-	0.12	2	-	-	0	0
9/3	46.7	45.4	18.5	1300	1320	3.15	61	3485	215	1	3
9/9	12.1	10.8	3.6	450	0	0.60	80	4572	120	1	2
9/14	5.0	3.7	2.9	275	0	0.35	41	2343	90	1	1
9/19	2.3	1.0	7.2	435	0	0.71	7	400	25	1	0
9/22	1.9	0.6	1.8	230	0	0.70	24	1372	50	1	1
10/7	6.3	5.0	8.8	0	1475	1.51	17	972	145	1	2
10/12	0.6	0	5.3	-	-	0.47	2	-	-	0	0
11/2	0.4	0	4.2	-	-	0.51	2	-	-	0	0
11/8	48.46	47.16	24	1330	2150	2.50	49	2800	165	1	2
11/14	26.1	24.8	13.6	1090	985	1.48	46	2629	80	1	2
11/20	5.85	4.55	7.7	0	400	1.03	18	1029	80	1	2
11/24	0.7	0	2.6	-	-	0	6	-	-	1	0
11/28	2.3	1.8	9.0	0	170	0.68	6	343	25	1	0
11/30	18.8	17.5	6.5	200	0	0.92	69	3943	100	1	3
12/4	20.4	19.1	14.3	725	0	1.22	34	1943	80	1	3
12/6	44.8	43.5	23.2	1625	975	0.98	46	2629	150	1	3
12/22	2.0	0.7	6.2	150	0	0.92	7	400	25	1	0
12/31	0.4	0	5.5	-	-	1.06	1	-	-	0	0
Total	584.49	522.44	473.5	19865	12975		1410	75669			
				32840							
Avg.	10.25	11.87	8.3	576			25	1940			

① melting show

② test activation

1973 - OPERATIONAL DATA

Date	Volume Into Station (mg)	Volume Discharged to River (mg)	Duration of Activation (hrs)	NaOCl (gal) Com.	NaOCl (gal) Ionic	Total Rainfall (in)	Average Pumping Rate (mgd)	Surface Loading Rate (gal/ft²/d)	Peak Pumping Rate (mgd)	Pumps Used Elect.	Pumps Used Diesel
1/23	0.39	0	2.8	60	0	0.55	2	-	-	1	0
1/29	0.18	0	1.1	-	-	1.58	2	-	-	0	0
2/2	32.4	31.1	15.4	950	0	1.11	50	2858	115	1	2
2/3	0.26	0.16	4.3	125	0	0	1	57	28	0	1
2/4	0.3	0	1.8	-	-	0	3	-	-	0	0
3/8	15.7	14.4	5.3	590	0	0.39	71	4058	100	0	2
3/17	0.4	0	4.0	-	-	0.69	2	-	-	0	0
4/1	38.4	37.1	21.7	1890	0	2.47	42	2400	100	0	3
4/4	6.55	5.25	7.1	1310	0	0.68	22	1257	55	0	3
4/6	0.5	0	6.0	-	-	0	2	-	0	0	0
4/10	4.3	3.0	4.2	450	0	0.62	24	1372	25	0	0
5/9	2.38	1.08	1.1	40	0	0.68	50	2858	80	1	1
5/21	6.8	5.5	2.3	25	0	0.96	70	4001	130	1	1
6/13	4.7	3.4	8.4	80	0	0.73	13	743	-	1	1
6/27	4.4	3.1	1.1	0	0	0.34	94	5372	-	1	-
6/29	-	0	4.3	40	0	0.48	-	-	-	-	0
6/30	-	-	2.3	170	0	0.42	-	-	-	1	1
6/30	-	-	2.5	170	0	0.68	-	-	-	0	0
7/5	4.4	3.1	2.3	180	0	0.56	45	2572	-	1	0
7/27	4.25	2.95	3.8	200	0	0.88	26	1486	-	1	1
7/29	9.5	8.2	4.9	350	0	1.73	46	2629	-	1	2
8/15	1.40	0.18	6.0	60	0	1.22	6	343	-	1	1
8/17	1.70	0.40	-	95	0	0	-	-	-	0	2
9/18	2.94	1.64	4.0	500	0	1.03	17	972	-	0	2
10/19	2.65	1.35	1.0	150	0	-	61	3486	-	1	2
10/30	8.38	7.08	3.0	486	0	1.78	66	3772	-	1	-
12/5	5.95	4.65	-	400	0	0.40	-	-	-	-	3
12/17	16.34	15.04	11.0	528	0	2.95	36	2057	-	1	3
12/21	2.37	1.07	1.5	250	0	0.70	36	2057	-	1	0
Total	177.62	149.75	133.2	9099	0	23.63	787	44350			
Avg.	6.83	5.58	4.93	364	0	0.84	33	2334			

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1974 - OPERATIONAL DATA

Date	Volume Into Station (mg)	Volume Discharged to River (mg)	Duration of Activation (hrs)	NaOCl (gal)		Total Rainfall (in)	Average Pumping Rate (mgd)	Surface Loading Rate (gal/ft^2/d)	Peak Pumping Rate (mgd)	Pumps Used	
				Com.	Ionic					Elect.	Diesel
2/2	32.5	31.2	12.8	950	0	0.77	61	3406	-	-	-
2/19	10.3	9.0	4.8	400	0	1.33	51	2915	165	1	2
3/21	18.0	16.7	5.8	950	0	2.07	74	4229	170	1	3
4/9	2.09	0.79	3.0	175	0	1.03	16	914	75	1	2
4/15	1.44	0.14	3.3	300	0	0.82	10	572	50	1	1
4/23	0.36	0	1.6	100	0	0.58	4	-	40	1	0
5/10	0.76	0	4.0	200	0	0.58	4	-	22	1	0
5/12	1.1	0	5.0	100	0	0.61	5	-	22	1	0
6/1	1.59	0.29	2.5	100	0	0.89	14	800	23	1	0
6/22	0.30	0	0.5	25	0	0.14	10	-	24	1	0
Total	68.44	58.12	43.3	3300			249	12916			
Avg.	6.84	9.69	4.33	330			25	2153			

APPENDIX B

RAINFALL DATA

NOTE

All rainfall data is taken from the National Weather Service Station at Boston Logan Airport. This station is directly on the ocean (Boston Harbor) and approximately 5 miles east of the Cottage Farm Station and its tributary area. The elevation of areas tributary to the Cottage Farm Station varies from 10 to 250 feet above mean sea level.

ESTIMATED RAINFALL INTENSITIES SUFFICIENT TO CAUSE DIVERSION TO THE COTTAGE FARM STATION FOR VARIOUS STORM DURATIONS

	Rainfall Intensity (in./hr.) to Cause Diversion from:	
Length of Storm (hrs)	North Charles Relief Sewer	South Charles Relief Sewer
1	0.24	0.72
2	0.16	0.37
3	0.14	0.25

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1971 - RAINFALL DATA

Date	Time Station Activated	Rainfall Prior To Activation (hrs)	Average Intensity Prior To Activation (in/hr)	Maximum Intensity Prior To Activation (in/hr)	Duration Of Maximum Intensity Prior to Activation (hr)	Total Rainfall (in)	Total Duration of Rainfall (hr)	Antecedent Dry Days	Hours of Rainfall After Activation Ended
5/13	12 n.	3	0.09	0.16	1.0	0.68	12	2	3.5
5/16	3 p.m.	9	0.07	0.12	1.0	1.10	22	1	3.9
6/3	7 p.m.	3	0.23	0.41	1.0	0.46	3	3	-1.1
6/8	7 p.m.	2	0.23	0.40	1.0	0.47	2	3	-2.3
6/21	9 p.m.	3	0.23	0.41	1.0	0.48	4	12	0.7
7/1	7 p.m.	3	0.13	0.25	1.0	0.48	5	5	0.8
7/17	9 p.m.	1	0.24	0.24	1.0	0.35	2	2	0.3
7/19	12 n.	1	0.08	0.08	1.0	0.77	11	1	0.4
7/20	6 p.m.	5	0.11	0.22	1.0	0.62	11	0	1.9
8/20	3 a.m.	1	0.18	0.18	1.0	0.23	3	7	2.6
8/27	9 a.m.	0	0	0	0	0.76	11	6	6.9
9/9	4 p.m.	1	0.09	0.09	1.0	0.09	1	11	-1.7
9/15	11 p.m.	3	0.16	0.36	1.0	0.93	13	0	6.7
10/6	3 p.m.	3	0.08	0.12	1.0	0.26	3	14	-2.3
10/10	2 p.m.	9	0.10	0.26	2.0	1.30	13	3	-0.4
11/25	10 a.m.	8	0.10	0.24	1.0	3.39	19	2	-7.5
11/28	3 a.m.	6	0.09	0.13	1.0	0.28	8	0	0.1
11/29	6 p.m.	3	0.07	0.13	1.0	1.09	8	0	-1.0
TOTAL		63	2.28	4.05		13.38	151	72	21.5
AVERAGE		3.5	0.13	0.23		0.74	8.4	4.0	1.7

9-1/2"

1972 - RAINFALL DATA

Date	Time Station Activated	Rainfall Prior To Activation (hrs)	Average Intensity Prior To Activation (in/hr)	Maximum Intensity Prior To Activation (in/hr)	Duration Of Maximum Intensity Prior to Activation (hr)	Total Rainfall (in)	Total Duration of Rainfall (hr)	Antecedent Dry Days	Hours of Rainfall After Activation Ended
1/2	5pm	2.5	0.02	0.02	1.0	1.07	7	1	1.3
1/19	4pm	0	0	0	0	0	0	5	-
2/3	[illegible]	14.8	0.02	0.14	0.8	1.19	19	0	-6.0
2/13	5pm	3.0	0.05	0.12	0.3	0.50	8	5	0.8
2/29	3pm	①	-	-	-	-	-	0	-
3/1	2pm	①	-	-	-	-	-	1	-
3/3	3am	2.0	0.03	0.03	1.0	1.92	26	0	1.0
3/8	8am	0.2	Tr	Tr	-	0.37	10	2	-4.8
3/16	1pm	5.0	Tr	Tr	5.0	Tr	5	0	-4.5
3/17	6am	3.3	0.06	0.08	2.3	0.59	12	1	-22.1
3/22	9am	4.0	0.02	0.03	2.0	0.50	17	0	-1.0
3/24	-	-	-	-	-	Tr	-	1	-
4/13	3pm	3.5	0.04	0.08	0.5	0.54	8	1	0.7
4/17	1am	7.0	0.07	-	-	0.13	7	0	-1.7
4/20	10am	5.5	0.06	0.10	0.5	0.72	13	2	3.2
4/23	2am	-	-	-	-	-	-	2	-
5/3	8pm	4.6	0.12	0.34	0.6	1.40	20	0	8.6
5/9	9am	②	-	-	-	-	-	-	-
5/9	6pm	12.5	0.04	0.08	-	0.68	20	0	-0.5
5/15	5am	4.1	0.08	0.19	1.1	1.14	11	0	2.1
5/20	6pm	9.9	0.05	0.19	0.9	0.63	13	0	-2.5
5/31	6pm	0.5	0.03	0.05	0.5	1.29	15	10	-1.8
6/4	7pm	1.6	0.25	0.25	1.6	1.25	13	2	-3.2
6/7	1pm	3.3	0.03	0.04	0.3	0.46	6	1	-1.0
6/9	10pm	6.1	0.07	0.28	1.1	1.46	17	0	-32.2
6/17	7am	-	-	-	-	0.40	3	0	
6/19	8am	6.6	0.07	0.14	1.6	0.23	6	0	-1.7
6/22	2pm	3.0	0.16	0.29	3.0	0.35	4	2	-0.3
6/23	12N	3.5	0.06	0.08	3.5	0.17	3	0	-2.8
6/30	1pm	3.5	0.14	0.29	0.5	0.49	4	6	-3.6

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1972 - RAINFALL DATA (Continued)

Date	Time Station Activated	Rainfall Prior To Activation (hrs)	Average Intensity Prior To Activation (in/hr)	Maximum Intensity Prior To Activation (in/hr)	Duration Of Maximum Intensity Prior to Activation (hr)	Total Rainfall (in)	Total Duration of Rainfall (hr)	Antecedent Dry Days	Hours of Rainfall After Activation Ended
7/13	4pm	3.0	0.13	0.37	0.7	0.55	4	7	-2.3
7/19	7pm	2.0	0.04	0.06	0.6	0.11	3	5	-4.6
7/21	10pm	1.0	0.10	0.10	1.0	0.10	1	1	-1.0
7/24	1am	-	-	-	-	1.03	5	0	
7/24	12M	-	-	-	-	0.03	1	0	
7/25	12M	2.0	0.05	0.05	2.0	0.10	2	0	-6.5
7/26	2pm	-	-	-	-	-	-	0	
8/1	3am	4.5	0.05	0.07	2.5	0.27	6	0	-1.2
8/8		1.5	0.06	0.11	1.5	0.12	2	0	-0.5
9/3		4.4	0.09	0.20	1.4	3.15	16	6	-6.9
9/9	12M	0.8	0.12	0.12	0.8	0.68	5	5	0.6
9/14	4pm	-	Tr	Tr	-	0.35	2	0	-
9/19	4pm	7.6	0.05	0.19	1.6	0.71	16	4	1.2
9/22	3am	3.5	0.22	0.49	0.5	0.70	4	0	-1.3
10/7	7am	3.0	0.16	0.33	1.0	1.51	12	6	0.2
10/12	4pm	3.4	0.10	0.16	1.4	0.47	6	3	-2.7
11/2	1pm	4.8	0.06	0.07	0.8	0.51	13	3	4.0
11/8	7pm	3.6	0.05	0.10	0.6	2.50	25	2	-2.6
11/14	10am	3.1	0.05	0.07	1.0	1.48	18	2	1.3
11/20	3am	4.2	0.06	0.07	0.2	1.03	10	0	-1.9
11/24		-	-	-	-	-	-	3	-
11/26		4.6	0.06	0.10	1.6	0.68	9	5	-4.6
11/30	11pm	3.5	0.05	0.09	2.5	0.92	11	1	1.0
12/4	10pm	8.8	0.04	0.09	0.8	1.22	15	2	-8.1
12/6	11am	-	Tr	Tr	-	0.98	11	0	12.2
12/22	9am	11.5	0.04	0.10	0.5	0.92	18	0	0.3
12/31	11pm	15.0	0.04	0.15	-	1.06	25	0	4.5
Total		205.8	3.25	5.91		38.76	507	95	-90.9
Average		4.7	0.06	0.14		0.81	10.4	1.7	-2.0

① melting snow

② test activation

1973 - RAINFALL DATA

Date	Time Station Activated	Rainfall Prior To Activation (hrs)	Average Intensity Prior To Activation (in/hr)	Maximum Intensity Prior To Activation (in/hr)	Duration Of Maximum Intensity Prior to Activation (hr)	Total Rainfall (in)	Total Duration of Rainfall (hr)	Antecedent Dry Days	Hours of Rainfall After Activation Ended
1/23	1am	6.0	0.04	0.26	1.0	0.55	8	0	-0.8
1/29	11 a.m	2.0	0.02	0.25	1.0	1.58	21	0	17.9
2/2	3 p.m.	3.0	0.05	0.08	1.0	1.11	19	3	0.6
2/3	10 a.m.	0	0	0	0	0	0	0	-
2/4	1 a.m.	0	0	0	0	0	0	0	-
3/8	8 a.m.	1.0	0.01	0.01	1.0	0.39	12	0	-2.6
3/17	1 p.m.	11.0	0.04	0.08	1.0	0.69	17	1	2.0
4/1	5 p.m.	2.0	0.05	0.20	1.0	2.47	34	0	10.3
4/4	5 p.m.	2.0	0.03	0.08	1.0	0.60	13	0	3.9
4/6	2 p.m.	0	0	0	0	0	0	0	-
4/10	9 a.m.	1.4	0.03	0.09	1.0	0.63	5	4	-0.6
5/9	6 p.m.	12.5	0.05	0.15	1.0	0.68	15	5	1.4
5/21	12 p.m.	5.0	0.16	0.46	1.0	0.96	5	0	-2.3
6/13	10 a.m.	4.0	0.10	0.18	1.0	0.73	11	0	-1.4
6/27	12 n.	3.0	0.06	0.09	1.0	0.34	14	0	9.9
6/29	8 p.m.	2.5	0.16	0.41	1.0	0.48	3	0	-3.8
6/30	7 a.m.	7	0.05	0.45	1.0	0.42	8	0	-1.3
6/30	11 p.m.	7	0.06	0.30	1.0	0.66	12	0	3.5
7/5	1 p.m.	6	0.09	0.26	1.0	0.36	8	0	-0.3
7/27	2 p.m.	4	0.13	0.50	1.0	0.88	5	5	-3.8
7/29	5 p.m.	4.5	0.35	0.97	1.0	1.73	7	1	-3.4
8/15	12 n.	8.0	0.09	0.15	1.0	1.22	16	3	-
8/17	-	0	0	0	0	0	0	3	-
9/18	1 p.m.	2	0.25	0.44	1.0	1.09	5	3	-1.0
10/19	-	-	-	-	-	-	-	0	-
10/20	6 a.m.	5	0.13	0.85	1.0	1.76	22	0	16.0
12/5	12 n.	4	0.05	0.08	1.0	0.40	5	6	-
12/17	8 a.m.	19	0.06	0.35	1.0	2.95	30	0	0
12/21	2 p.m.	3	0.17	0.31	1.0	0.70	5	3	0.5
TOTAL		125.0	2.23	6.16		22.01	279	25	47.6
AVERAGE		5.7	0.09	0.28		1.00	12.7	1.3	2.2

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1974 - RAINFALL DATA

Date	Time Station Activated	Rainfall Prior To Activation (hrs)	Average Intensity Prior To Activation (in/hr)	Maximum Intensity Prior To Activation (in/hr)	Duration Of Maximum Intensity Prior to Activation (hr)	Total Rainfall (in)	Total Duration of Rainfall (hr)	Antecedent Dry Days	Hours of Rainfall After Activation Ended
2/2	3 p.m.	6.0	0.37	0.10	1.0	0.77	16	4	-2.5
2/19	11 p.m.	5.0	0.39	0.31	1.0	1.33	10	1	0.2
2/21	3 p.m.	6.0	0.17	0.39	1.0	2.07	9	3	2.8
4/9	11 a.m.	11.0	0.06	0.18	1.0	1.05	16	0	-2.0
4/13	1 a.m.	1.0	0.43	0.43	1.0	0.83	3	0	1.3
4/23	8 p.m.	6.0	0.08	0.26	1.0	0.88	7	2	0.6
5/10	1 p.m.	12.0	0.05	0.10	1.0	0.58	14	2	2.0
5/12	11 p.m.	1.0	0.30	0.30	1.0	0.61	3	1	3.0
6/1	11 a.m.	6.0	0.05	0.08	1.0	0.89	10	3	-1.5
6/22	4 p.m.	0.5	0.14	0.24	0.5	0.14	1	0	0
TOTAL		54.5	1.4[illegible]	2.39		8.34	89	16	3.9
AVERAGE		5.5	0.14	0.24		0.83	8.9	1.6	0.4

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APPENDIX C

SAMPLING DATA

May 1971 - June 1974

INFLUENT SAMPLES

1971

Storm Date	Volume Into Station (mg)	Duration of Activation (hrs)	Time of Sample	Fecal Coliform (1000/100 ml)	Total Coliform (1000/100 ml)	BOD (mg/l)	Cl^- (mg/l)	Total Solids (mg/l)	SS (mg/l)	VSS (mg/l)	Set. S (ml/l)	Turb. (mg/l)	Chlorine Demand (mg/l)
1971													
5/13	5.2	3.5	3.5	-	-	-	-	1097	942	137	-	-	15.0
5/16	7.2	5.1	1.5	-	-	-	-	-	136	100	-	-	2.9
			2.9	-	-	-	-	341	41	25	-	-	2.0
			4.9	-	-	-	-	444	104	52	-	-	3.0
6/8	3.27	2.3	0.8	-	-	-	-	740	-	-	-	-	1.4
			1.8	-	-	-	-	688	290	216	-	-	3.8
7/1	0.02	2.2	0.4	-	-	-	325	601	-	-	-	-	6.0
			1.1	-	-	-	425	415	-	-	-	-	4.0
10/6	0.29	2.3	0.2	1000	2000	-	-	1010	670	630	-	-	19.5
			0.4	200	700	-	-	973	600	413	-	-	13.8
			0.7	100	300	-	-	1124	516	344	-	-	8.8
			1.0	100	200	-	-	838	395	280	-	-	8.5
			1.3	-	100	-	-	671	312	184	-	-	6.7
11/29	6.16	6.0	0.3	100	1630	50.1	-	303	137	81	-	-	3.1
			0.5	180	1620	51.9	-	303	166	143	-	-	3.0
			0.8	240	2120	52.7	-	301	160	132	-	-	[illegible]
			1.1	100	1580	51.0	-	241	66	64	-	-	[illegible]
			1.5	140	2040	45.9	-	253	76	60	-	-	[illegible]
			2.0	40	1570	47.6	-	219	69	60	-	-	[illegible]
			3.0	50	980	44.2	-	185	[illegible]	60	-	-	1.0
			4.1	40	1030	35.6	-	133	93	60	-	-	1.9
			4.8	40	700	30.9	-	131	69	42	-	-	1.0

EFFLUENT SAMPLES

1971

Storm Date	Volume Discharged To River (mg)	Duration of Activation (hrs)	Time of Sample	Fecal Coliform (1000/100 ml)	Total Coliform (1000/100 ml)	BOD (mg/l)	Cl^- (mg/l)	Total Solids (mg/l)	SS (mg/l)	VSS (mg/l)	Set. S (ml/l)	Turb. (mg/l)	Chlorine Residual (mg/l)
1971													
5/13	3.9	3.5	3.5	-	-	-	-	297	124	38	-	-	-
5/16	5.9	5.1	1.6	-	-	-	-	-	100	74	-	-	-
			3.0	-	-	-	-	252	106	74	-	-	-
			5.0	-	-	-	-	250	72	84	-	-	-
6/8	1.97	2.3	1.5	-	-	-	-	493	188	118	-	-	-
7/1	0	2.2	-	-	-	-	-	-	-	-	-	-	-
10/6	0	2.3	-	-	-	-	-	-	-	-	-	-	-
11/29	4.06	6.0	2.5	100	1500	58.7	-	317	80	92	-	-	-
			3.2	-	800	52.7	-	290	114	86	-	-	-
			4.3	-	-	42.6	-	300	80	70	-	-	-
			5.0	-	300	52.7	-	300	154	100	-	-	-

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INFLUENT SAMPLES

1972

Storm Date	Volume Into Station (mg)	Duration of Activation (hrs)	Time of Sample	Fecal Coliform (1000/100 ml)	Total Coliform (1000/100 ml)	BOD (mg/l)	Cl^- (mg/l)	Total Solids (mg/l)	SS (mg/l)	VSS (mg/l)	Set. S (ml/l)	Turb. (mg/l)	Chlorine Demand (mg/l)
1972													
1/2	1.4	3.3	0.2 0.7 0.9 1.3	- - - -	- - 2000 2100	- - 130.0 180.0	[illegible]	1827 [illegible] 1100 900	[illegible]	[illegible]	13.0 12.0 10.0 7.0	- - - -	4.0 3.0 [illegible] 2.1
2/3	10.1	8.2	2.0 3.0 4.3	9 3 3	110 100 60	101.0 50.0 66.0	100 100 80	541 279 343	130 130 122	68 72 40	3.0 2.0 3.5	115 120 130	3.3 2.2 2.0
2/13	0.05	4.2	0.1 0.3 0.5 0.8 1.9	160 100 90 40 90	[illegible]	200.0 150.0 170.0 120.0 140.0	[illegible]	1100 [illegible]	[illegible]	313 [illegible]	12.0 6.0 6.5 7.5 4.5	600 [illegible] [illegible] [illegible] 175	- - - - -
3/3	71.3	23	1.0 2.2 2.8 4.2	30 6 4 3.7	[illegible]	100.0 75.0 60.0 50.0	56 40 40 25	513 [illegible]	200 140 62 70	100 54 19 25	3.6 1.0 Tr. 0.1	200 110 90 90	1.5 1.5 1.0 1.3
3/6	7.3	14.6	0.1 0.7 1.1 1.9 2.1	3 25 33 37 72	1000 [illegible]	90.0 90.0 100.0 100.0 80.0	165 145 150 135 130	543 674 [illegible] [illegible] 516	48 165 170 180 160	20 [illegible] [illegible] [illegible] 160	1.0 3.0 3.0 3.5 3.5	20 170 165 170 160	1.2 1.3 2.1 2.1 1.9
3/17	19.3	30.0	1.1 2.2* 1.8	15 - 10	2200 - 710	- - -	65 55 60	[illegible]	[illegible] [illegible] 162	104 122 76	- - -	100 130 120	- - -
4/13	0.9	3.0	0.5 1.0* 2.0	- - 40	- - 2700	- - 225.0	75 65 40	[illegible]	150 75 236	142 64 143	9.0 7.0 5.5	[illegible] 170 225	2.3 [illegible] [illegible]

INFLUENT SAMPLES

1972

Storm Date	Volume Into Station (mg)	Duration of Activation (hrs)	Time of Sample	Fecal Coliform (1000/100 ml)	Total Coliform (1000/100 ml)	BOD (mg/l)	Cl^- (mg/l)	Total Solids (mg/l)	SS (mg/l)	VSS (mg/l)	Set. S (ml/l)	Turb. (mg/l)	Chlorine Demand (mg/l)
4/20	1.1	4.3	1.0 1.3 2.3	40 80 10	3100 4000 1900	- - 160	45 40 45	201 290 265	95 75 79	70 53 73	6.0 5.5 5.0	100 125 105	3.1 3.0 2.1
5/15	3.10	4.0	1.1* 1.8 2.5	- 10 11	- 100 100	- 237.0 262.0	40 30 35	314 192 113	200 110 44	100 60 25	5.0 [illegible] 0.5	115 [illegible] 60	[illegible]
5/25	3.46	5.6	1.8	18	500	200.0	40	394	256	144	7.5	250	4.0
6/4	16.1	14.6	0.3 0.6 0.8 1.2	1.6 - - -	41000 - - -	- - - 170.0	110 60 70 80	1003 1010 7761 3300	660 706 5640 3076	219 410 4930 2775	10.0 16.5 60.0+ 60.0+	115 210 300 290	6.0 5.0 6.8 6.0
6/22	0.30	1.3	0.0 0.1 1.1	- - -	6200 3100 2700	120.0 270.0 -	90 75 85	503 529 523	102 180 217	75 134 187	3.5 7.0 7.0	160 270 190	6.1 3.2 3.0
9/2	65.7	10.5	1.0	140	9300	144.0	50	314	95	39	1.5	10	0.3
10/7	6.3	8.8	5.7	30	6700	130.0	25	167	63	40	1.0	90	1.0
11/9	65.65	34	3.3	61	1400	68.0	65	236	38	27	1.0	7.0	1.0

* Composite sample

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BOTTOM OF IMAGE AREA; OUTSIDE DIMENSION FOR TABLES AND ILLUSTRATIONS
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PAGE NUMBER
EPA-287 (Cin.)
(4-76)

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EFFLUENT SAMPLES

1972

Storm Date	Volume Discharged To River (mg)	Duration of Application (hrs)	Time of Sample	Fecal Coliform (1000/100 ml)	Total Coliform (1000/100 ml)	BOD (mg/l)	Cl⁻ (mg/l)	Total Solids (mg/l)	SS (mg/l)	VSS (mg/l)	Set. S (ml/l)	Turb. (mg/l)	Chlorine Residual (mg/l)
1972													
1/2	0.1	3.3	2.4	-	70000	112.0	250	780	111	73	0.7	-	-
			2.5	-	75000	104.0	250	775	93	67	0.2	-	-
			2.7	-	13000	104.0	250	684	98	61	0.6	-	-
			2.7	-	17000	-	-	-	-	-	-	-	-
2/3	16.0	8.2	2.8	10000	20000	126.0	415	950	144	65	4.5	120	-
			3.8	1000	21000	125.0	215	470	126	60	5.5	130	-
			6.3	-	800	45.0	160	500	102	62	3.5	160	3.9
			8.3	100		52.0	130	474	120	64	3.0	190	4.5
2/13	0	4.2	-	-	-	-	-	-	-	-	-	-	-
3/3	78.0	23.	1.4	-	-	110	90	519	330	60	1.0	200	1.2
			2.8	-	-	80	70	265	150	30	0.2	120	6.0
			6.3	-	-	80	65	254	80	25	Tr	80	6.0
			4.3	-	-	50	60	203	65	23	0.2	90	3.0
3/8	6.0	14.6	2.3	-	-	40	155	557	96	34	0.6	125	2.5
			2.8*	-	-	60	155	600	75	34	0.6	115	2.3
			3.3	-	-	110	135	500	72	41	1.0	100	1.3
3/17	36.0	30.0	1.8*	-	-	-	90	433	85	52	-	95	-
			2.3*	-	-	-	90	415	102	60	-	100	-
			4.2*	-	-	-	85	431	100	63	-	100	-
4/13	0	3.0	-	-	-	-	-	-	-	-	-	-	-
4/20	0	6.3	-	-	-	-	-	-	-	-	-	-	-
5/15	2.85	4.8	2.1	-	-	271.0	70	267	97	47	0.3	125	2.3
			2.8*	-	-	-	55	220	75	41	0.2	90	1.5
			2.8	-	-	305.0	50	210	70	36	0.1	80	1.4

EFFLUENT SAMPLES

1972 (page 2)

Storm Date	Volume Discharged To River (mg)	Duration of Application (hrs)	Time of Sample	Fecal Coliform (1000/100 ml)	Total Coliform (1000/100 ml)	BOD (mg/l)	Cl⁻ (mg/l)	Total Solids (mg/l)	SS (mg/l)	VSS (mg/l)	Set. S (ml/l)	Turb. (mg/l)	Chlorine Residual (mg/l)
5/20	2.16	5.6	4.1	-	-	130.0	70	275	51	32	Tr.	100	5.0
			3.1*	-	-	-	70	217	60	41	0.2	130	7.0
6/4	14.8	14.0	2.1*	-	1000	-	75	280	160	79	2.0	170	4.0
			2.9	-	-	100.0	70	280	46	29	3.0	105	3.0
6/22	0	1.3	-	-	-	-	-	-	-	-	-	-	-
9/3	46.4	18.5	1.3	-	1600	103.0	50	230	73	37	1.4	20	0.6
10/7	5.0	6.8	5.5	-	4800	60.0	25	215	65	49	1.6	100	0.2
11/8	47.16	26.	2.2	-	-	60.0	95	233	30	16	0.3	7.0	3.4

* Composite sample

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INFLUENT SAMPLES

1974

Storm Date	Volume Into Station (mg)	Duration of Activation (hrs)	Time of Sample	Fecal Coliform (1000/100 ml)	Total Coliform (1000/100 ml)	BOD (mg/1)	Cl⁻ (mg/1)	Total Solids (mg/1)	SS (mg/1)	VSS (mg/1)	Set. S (ml/1)	Turb. (mg/1)	Chlorine Demand (mg/1)
1974													
2/19	10.3	4.0	*	0	7000	68	-	-	293	106	5.0	-	-
3/21	18.0	5.0	*	0.2	10000	76	-	-	280	119	3.5	-	.
4/9	3.09	3.0	*	0	0.3	96	-	-	290	214	0.5	-	-
5/12	1.1	5.0	*	50	600000	56	-	-	124	46	0.0	-	-

*Composite Sample

EFFLUENT SAMPLES

1974

Storm Date	Volume Discharged To River (mg)	Duration of Activation (hrs)	Time of Sample	Fecal Coliform (1000/100 ml)	Total Coliform (1000/100 ml)	BOD (mg/1)	Cl⁻ (mg/1)	Total Solids (mg/1)	SS (mg/1)	VSS (mg/1)	Set. S (ml/1)	Turb. (mg/1)	Chlorine Residual (mg/1)
1974													
2/19	9.0	4.0	*	0	40	70	-	-	126	50	1.5	-	-
3/21	16.7	5.0	*	0	14	24		-	84	32	0.4	-	-
4/9	0.79	3.0	*	0	<0.1	67	-	-	78	46	Tr	-	-
5/12	0	5.0	*	< 0.1	<0.1	27	-	-	94	27	0.3	-	-

*Composite Sample

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BOTTOM OF IMAGE AREA, OUTSIDE DIMENSION FOR TABLES AND ILLUSTRATIONS
3/8"

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APPENDIX D COMPUTED REMOVALS

SUSPENDED SOLIDS 1971

DATE	INF. VOLUME (MG)	EFF. VOLUME (MG)	STORED VOLUME (MG)	INF. CONC. (mg/1)	% REMOVAL	POUNDS INF.	POUNDS REMOVED FROM EFF.	POUNDS STORED	TOTAL POUNDS REMOVED	OVERALL & REMOVAL
5-13	5.20	3.90	1.30	542.0	77.0	23494.	13568.	5874.	19441.	83.
5-16	7.20	5.90	1.30	94.0	1.0	5642.	46.	1019.	1065.	19.
6-08	3.27	1.97	1.30	240.0	22.0	6542.	867.	2601.	3468.	53.
7-01	0.82	0.0	0.82	0.0	100.0	0	0.	0.	0.	0.
10-06	0.29	0.0	0.29	514.0	100.0	1243.	0.	1243.	1243.	100.
11-29	6.16	4.86	1.30	105.0	0.0	5392.	0.	1138.	1138.	21.
TOTAL	22.94	16.63	6.31			42312.	14481.	11873.	26355.	
AVG/MG				229.5	29.7	1913.	1230.	2163.		
TOTAL FOR YEAR	49.92	34.47	15.45			95490.	42410.	33414.	75824.	79.

VOLATILE SUSPENDED SOLIDS 1971

DATE	INF. VOLUME (MG)	EFF. VOLUME (MG)	STORED VOLUME (MG)	INF. CONC. (MG/L)	% REMOVAL	POUNDS INF.	POUNDS REMOVED FROM EFF.	POUNDS STORED	TOTAL POUNDS REMOVED	OVERALL & REMOVAL
5-13	5.20	3.90	1.30	137.0	77.0	5939.	3430.	1485.	4914.	83.
5-16	7.20	5.90	1.30	76.0	11.0	4561.	411.	824.	1235.	27.
6-08	3.27	1.97	1.30	216.0	45.0	5888.	1596.	2341.	3937.	67.
7-01	0.82	0.0	0.82	0.0	100.0	0.	0.	0.	0.	0.
10-06	0.29	0.0	0.29	337.0	100.0	815.	0.	815.	815.	100.
11-29	6.16	4.86	1.30	76.0	0.0	3903.	0.	824.	824.	21.
TOTAL	22.94	16.63	6.31			21105.	5437.	6287.	11724	
AVG/MG SAMPLED				114.5	38.6	954.	462.	1145.		
TOTAL FOR YEAR	49.92	34.47	15.45			47630.	15923.	17694.	33616.	71.

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BIOCHEMICAL OXYGEN DEMAND 1972

DATE	INF. VOLUME (MG)	EFF. VOLUME (MG)	STORED VOLUME (MG)	INF. CONC. (mg/1)	% REMOVAL	POUNDS INF.	POUNDS REMOVED FROM EFF.	POUNDS STORED	TOTAL POUNDS REMOVED	OVERALL & REMOVAL
1-02	1.40	0.10	1.30	138.0	23.0	1611.	26.	1495.	1522.	94.
1-19	1.60	0.30	1.30	300.0	5.0	4001.	38.	3251.	3289.	82.
2-03	18.10	16.80	1.30	70.6	0.0	10652.	0.	765.	765.	7.
2-13	0.85	0.0	0.85	100.0	100.0	1346.	0.	1346.	1346.	100.
3-03	71.30	70.00	1.30	75.0	7.0	44577.	3063.	813.	3876.	9.
3-08	7.30	6.00	1.30	90.0	22.0	5477.	990.	975.	1966.	36.
3-17	19.30	18.00	1.30	0.0	0.0	0.	0.	0.	0.	0.
4-13	0.90	0.0	0.90	225.0	100.0	1688.	0.	1688.	1688.	100.
4-20	1.10	0.0	1.10	150.0	100.0	1375.	0.	1375.	1375.	100.
5-15	3.85	2.55	1.30	250.5	0.0	8328.	0.	2812.	2812.	34.
5-20	3.46	2.16	1.30	200.0	35.0	5760.	1260.	2167.	3428.	50.
6-22	0.20	0.0	0.20	245.0	100.0	408.	0.	498.	498.	100.
9-03	46.70	45.40	1.30	144.0	28.0	56058.	15250.	1561.	16820.	30.
10-07	6.30	5.00	1.30	130.0	54.0	9827.	2026.	1460.	4335.	63.
11-08	48.46	47.16	1.30	68.0	0.0	27460.	0.	737.	737.	3.
TOTAL	230.82	213.47	17.35			175587.	23563.	20804.	44367.	
AVG/MG SAMPLED				90.6	17.4	839.	183.	1296.		
TOTAL FOR YEAR	584.49	522.44	62.05			485196.	95459.	80427.	175887.	36.

SUSPENDED SOLIDS 1972

DATE	INF. VOLUME (MG)	EFF. VOLUME (MG)	STORED VOLUME (MG)	INF. CONC. (mg/1)	% REMOVAL	POUNDS INF.	POUNDS REMOVED FROM EFF.	POUNDS STORED	TOTAL POUNDS REMOVED	OVERALL & REMOVAL
1-02	1.40	0.10	1.30	364.0	73.0	4248.	222.	3945.	4166.	98.
1-10	1.60	0.30	1.30	113.0	43.0	1507.	122.	1225.	1346.	89.
2-03	18.10	16.80	1.30	120.0	1.0	12464.	181.	1398.	1579.	8.
2-13	0.85	0.0	0.85	351.0	100.0	2487.	0.	2487.	2487.	100.
3-03	71.30	70.00	1.30	150.0	2.0	89154.	1751.	1626.	3376.	4.
3-08	7.30	6.00	1.30	144.0	44.0	8763.	3160.	1569.	4730.	54.
3-17	10.30	18.00	1.30	100.0	59.0	32016.	14930.	2157.	17086.	53.
4-13	0.00	0.0	0.90	156.0	100.0	1170.	0.	1170.	1170.	100.
4-20	1.10	0.0	1.10	84.0	100.0	770.	0.	770.	770.	100.
5-15	3.85	2.55	1.30	147.0	44.0	4718.	1375.	1593.	2968.	63.
5-20	3.46	2.16	1.30	246.0	76.0	7095.	3366.	2666.	6032.	85.
6-22	0.20	0.0	0.20	166.0	100.0	277.	0.	277.	277.	100.
9-03	46.70	45.40	1.30	58.0	0.0	22579.	0.	629.	629.	3.
10-07	6.30	5.00	1.30	62.0	0.0	3256.	0.	672.	672.	21.
11-08	48.46	47.16	1.30	38.0	11.0	15351.	1643.	412.	2055.	13.
TOTAL	230.82	213.47	17.35			212854.	26758.	22585.	49343.	
AVG/MG SAMPLED				110.6	13.1	922.	164.	1302.		
TOTAL FOR YEAR	594.49	522.44	62.05			538996.	85725.	80773.	166498.	31.

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VOLATILE SUSPENDED SOLIDS 1972

DATE	ING. VOLUME (MG)	EFF. VOLUME (MG)	STORED VOLUME (MG)	INF. CONC. (mg/l)	% REMOVAL	POUNDS INF.	POUNDS REMOVED FROM EFF.	POUNDS STORED	TOTAL POUNDS REMOVED	OVERALL & REMOVAL
1-02	1.40	0.10	1.30	273.0	77.0	3186.	175.	2958.	3134.	98.
1-10	1.60	0.30	1.30	84.0	52.0	1120.	109.	910.	1020.	91.
2-03	18.10	16.80	1.30	57.0	0.0	8600.	0.	618.	618.	7.
2-13	0.85	0.0	0.85	223.0	100.0	1580.	0.	1580.	1580.	100.
3-03	71.30	70.00	1.30	57.0	16.0	33878.	5322.	618.	5939.	18.
3-08	7.30	6.00	1.30	70.0	39.0	4260.	1365.	750.	2124.	50.
3-17	19.30	18.00	1.30	128.0	57.0	20593.	10948.	1387.	12335.	60.
4-13	0.90	0.0	0.90	116.0	100.0	870.	0.	870.	870.	100.
4-20	1.10	0.0	1.10	65.0	100.0	596.	0.	596.	596.	100.
5-15	3.85	2.55	1.30	69.0	41.0	2214.	601.	748.	1349.	61.
5-20	3.46	2.16	1.30	144.0	74.0	4153.	1919.	1560.	3479.	84.
6-22	0.20	0.0	0.20	125.0	100.0	208.	0.	208.	208.	100.
9-03	46.70	45.40	1.30	34.0	0.0	13236.	0.	368.	368.	3.
10-07	6.30	5.00	1.30	40.0	0.0	2101.	0.	433.	433.	21.
11-08	48.46	47.16	1.30	27.0	41.0	10907.	4352.	293.	4644.	43.
TOTAL	230.82	213.47	17.35			107504.	24791.	13907.	38698.	
AVG/MG SAMPLED				55.9	31.5	466.	169.	802.		
TOTAL FOR YEAR	584.49	522.44	62.05			272225.	88547.	49738.	138285.	51.

SETTLEABLE SOLIDS 1972

DATE	INF. VOLUME (MG)	EFF. VOLUME (MG)	STORED VOLUME (MG)	INF. CONC. (ml/1)	% REMOVAL	CU.FT. INF.	CU.FT. REMOVED FROM EFF.	CU.FT. STORED	TOTAL CU.FT. REMOVED	OVERALL & REMOVAL
1-02	1.40	0.10	1.30	10.4	96.0	1947.	133.	1808.	1941.	100.
1-19	1.60	0.30	1.30	5.0	80.0	1070.	160.	869.	1029.	96.
2-03	18.10	16.80	1.30	2.8	0.0	6776.	0.	487.	487.	7.
2-13	0.85	0.0	0.85	7.7	100.0	875.	0.	875.	875.	100.
3-03	71.30	70.00	1.30	1.2	73.0	11439.	8198.	209.	8407.	73.
3-08	7.30	6.00	1.30	3.0	77.0	2928.	1853.	521.	2375.	81.
3-17	19.30	18.00	1.30	0.0	0.0	0.	0.	0.	0.	0.
4-13	0.90	0.0	0.90	7.2	100.0	866.	0.	866.	866.	100.
4-20	1.10	0.0	1.10	5.5	100.0	809.	0.	800.	809.	100.
5-15	3.85	2.55	1.30	2.7	92.0	1390.	847.	469.	1316.	95.
5-20	3.46	2.16	1.30	7.5	99.0	3470.	2144.	1304.	3448.	99.
6-22	0.20	0.0	0.20	5.8	100.0	155.	0.	155.	155.	100.
9-03	46.70	45.40	1.30	1.5	7.0	9366.	637.	261.	898.	10.
10-07	6.30	5.00	1.30	1.8	11.0	1516.	132.	313.	445.	29.
11-08	48.46	47.16	1.30	1.0	70.0	6479.	4414.	174.	4588.	71.
TOTAL	230.82	213.47	17.35			49085.	18520.	9119.	27639.	
AVG/MG SAMPLED				1.7	54.4	232.	104.	568.		
TOTAL FOR YEAR	584.49	522.44	62.05			135637.	54154.	35254.	89408.	66.

BIOCHEMICAL OXYGEN DEMAND 1974

DATE	INF. VOLUME (MG)	EFF. VOLUME (MG)	STORED VOLUME (MG)	INF. CONC. (mg/1)	% REMOVAL	POUNDS INF.	POUNDS REMOVED FROM EFF.	POUNDS STORED	TOTAL POUNDS REMOVED	OVERALL & REMOVAL
2-20	10.30	9.00	1.30	65.0	0.0	5581.	0.	704.	704.	13.
3-22	18.00	16.70	1.30	76.0	68.0	11404.	7194.	824.	8018.	70.
4-09	2.00	0.79	1.30	96.0	30.0	1673.	190.	1049.	1239.	74.
5-12	1.10	0.0	1.10	46.0	41.0	422.	0.	422.	422.	100.
TOTAL	31.49	26.49	5.00			19079.	7384.	2990.	10374.	
AVG/MG SAMPLED				72.7	66.3	606.	422.	598.		
TOTAL FOR YEAR	68.44	58.12	10.32			41466.	24538.	6172.	30709.	74.

SUSPENDED SOLIDS 1974

DATE	INF. VOLUME (MG)	EFF. VOLUME (MG)	STORED VOLUME (MG)	INF. CONC. (mg/1)	% REMOVAL	POUNDS INF.	POUNDS REMOVED FROM EFF.	POUNDS STORED	TOTAL POUNDS REMOVED	OVERALL & REMOVAL
2-20	10.30	9.00	1.30	293.0	57.0	25157.	12530.	3175.	15705.	62.
3-22	18.00	16.70	1.30	229.0	63.0	34361.	20084.	2482.	22566.	66.
4-09	2.09	0.79	1.30	250.0	69.0	4356.	1130.	2780.	3845.	88.
5-12	1.10	0.0	1.10	124.0	24.0	1137.	0.	1137.	1137.	100.
TOTAL	31.49	26.49	5.00			65011.	33750.	9503.	43253.	
AVG/MG SAMPLED				247.7	61.1	2064.	1274.	1901.		
TOTAL FOR YEAR	68.44	58.12	10.32			141204.	74048.	19614.	93662.	66.

EPA-287 (Cin.)
(4-76)

VOLATILE SUSPENDED SOLIDS 1974

DATE	INF. VOLUME (MG)	EFF. VOLUME (MG)	STORED VOLUME (MG)	INF. CONC. (mg/1)	% REMOVAL	POUNDS INF.	POUNDS REMOVED FROM EFF.	POUNDS STORED	TOTAL POUNDS REMOVED	OVERALL & REMOVAL
2-20	10.30	9.00	1.30	104.0	52.0	8930.	4057.	1127.	5184.	58.
3-22	18.00	16.70	1.30	119.0	73.0	17856.	12093.	1200.	13383.	75.
4-09	2.09	0.79	1.30	214.0	79.0	3728.	1113.	2319.	3432.	92.
5-12	1.10	0.0	1.10	46.0	41.0	422.	0.	422.	422.	100.
TOTAL	31.49	26.49	5.00			30935.	17264.	5157.	22421.	
AVG/MG SAMPLED				117.8	66.0	982.	652.	1031.		
TOTAL FOR YEAR	68.44	58.12	10.32			67235.	37878.	10645.	48523.	72.

SETTLEABLE SOLIDS 1974

DATE	INF. VOLUME (MG)	EFF. VOLUME (MG)	STORED VOLUME (MG)	INF. CONC. (ml/1)	% REMOVAL	CU.FT. INF.	CU.FT. REMOVED FROM EFF.	CU.FT. STORED	TOTAL CU.FT. REMOVED	OVERALL & REMOVAL
2-20	10.30	9.00	1.30	5.0	70.0	6886.	4212.	869.	5081.	74.
3-22	18.00	16.70	1.30	3.5	89.0	8423.	6955.	608.	7563.	90.
4-09	2.09	0.79	1.30	0.5	90.0	140.	48.	87.	134.	96.
5-12	1.10	0.0	1.10	0.8	62.0	118.	0.	118.	118.	100.
TOTAL	31.49	26.49	5.00			15566.	11214.	1682.	12896.	
AVG/MG SAMPLED				3.7	82.6	494.	423.	336.		
TOTAL FOR YEAR	68.44	58.12	10.32			33831.	24604.	3472.	28076.	83.

APPENDIX E

SUMMARY OF FY 1975 OPERATIONS

July 1, 1974 - June 30, 1975

COTTAGE FARM STORM WATER DETENTION AND CHLORINATION STATION

The Cottage Farm Storm Water Detention and Chlorination Station was activated May, 1971, and is located on the Cambridge side of the Charles River just west of the Boston University Bridge. It receives the excess storm flow from combined sewers in Cambridge, Brookline and the South Charles Relief Sewer. The normal dry weather flow and minor storm flow up to capacity of the sewer will continue to flow to the Ward Street Headworks and then to the Deer Island Sewage Treatment Plant. The design flow of the Cottage Farm Storm Water Detention and Chlorination Station is 233.1 m.g.d.

No. of Times Plant was Activated	33	
Total Amount Received by Station	462.71	Mil. Gal.
No. of Times Overflow Occurred into the Charles River	22	
Total Amount of Overflow into the Charles River	419.81	Mil. Gal.
Total Amount of Sodium Hypochlorite Used	16,220.00	Gal.
Minimum Rainfall	0.2	Inch
Maximum Rainfall	3.2	Inch
Average Rainfall	1.28	Inch

OPERATIONAL DATA *

BOD. 5 Day

Influent - mg/l	114.3
Effluent - mg/l	92.7
Removal, %	18.9%

Suspended Solids

Influent - mg/l	150.2
Effluent - mg/l	77.8
Removal, %	48.2%

Setteable Solids

Influent - ml/l	3.61
Effluent - ml/l	0.70
Removal, %	80.61%

Bacterial Concentration (Total Coliform)

Influent - MF/100 ml	15×10^6
Effluent - MF /100 ml	< 1000
Removal, %	99.99%

*Based on Composite Samples From Actual Discharges

OUTFALLS

4-Outfalls
  2 Effluent, 30' depth, 5' dia., 6000' long.
  1 Effluent, 20' depth, 5' dia., 1400' long.
  1 Effluent, (offshore emergency) 5' dia., 468' long.

1-Digested sludge disposal line, 12" dia., 4.2 miles long.

CHLORINATION

4-Chlorinators of 8,000 lb/day cap., providing pre and post-chlorination.

ADMINISTRATION BUILDING

Storage facilities for 45-ton containers liquid chlorine.

First Aid Room

Chemical and Bacteriological Laboratory

Clerical Offices

2-Boilers, vertical, fire tube, dual fuel fired, 3,000,000 Btu/hr. each.

1-0-5 ppm chlorine residual analyzer.